



urn:lsid:zoobank.org:pub:98D842A8-470C-46D1-A60F-6CF474D8B902

# Four new species of the genus *Cnemaspis* Strauch, 1887 (Sauria: Gekkonidae) from the northern Western Ghats, India

<sup>1</sup>Amit Sayyed, <sup>2</sup>Robert Alexander Pyron, and <sup>3</sup>R. Dileepkumar

<sup>1</sup>Wildlife Protection and Research Society, INDIA <sup>2</sup>Department of Biological Sciences, The George Washington University, 2029 G St. NW, Washington, D.C. 20052, USA <sup>3</sup>YIPB Department of Biotechnology, University of Kerala, INDIA

**Abstract.**—We report four new species of geckos of the genus *Cnemaspis* Strauch, 1887 from the northern Western Ghats, India. *Cnemaspis limayei* sp. nov. is diagnosable by the following combination of characters: dorsal scales heterogeneous; spine-like tubercles absent on flank; pre-anal scales larger than ventral; 26–27 scale rows across the belly, between lowest rows of dorsal scales; supralabial I narrowly contacting nasal; mental posteriorly pointed; two pairs of postmentals; males with 4–5 femoral pores on each side. *C. ajijae* sp. nov. is diagnosable by: dorsal scales heterogeneous; granular keeled scales intermixed with large keeled depressed scales; conical and spine-like tubercles absent on flank; 29–30 scale rows across the belly; three pairs of postmentals; males with 3–4 femoral pores on each side. *C. amboliensis* sp. nov. is diagnosable by: dorsal scales heterogeneous; granular, keeled small scales intermixed with some large keeled scales; conical and spine-like tubercles on flank; scales on snout feebly keeled; dorsal scales on forelimb and hindlimb tricarinate; males with 3–4 pre-anal pores and 3–4 femoral pores on each side of the thigh. *C. mahabali* sp. nov. is diagnosable by: dorsal scales on body heterogeneous; conical and spine-like tubercles absent on flank; 26–27 scale rows across the belly; scales on ventral part of neck feebly carinate; dorsal scales on forelimb and hindlimb are strongly keeled; three femoral pores on each side. These four new species are distinguished by morphological comparison, morphometric, and genetic analysis, leading to a re-appraisal of the genus *Cnemaspis* in India. The description of these new species from the Western Ghats suggests that our understanding of species richness within this genus is still incomplete. Understanding the diversity of species in *Cnemaspis* will help in determining the conservation status of these threatened taxa.

**Keywords.** Species conservation, morphology, *Cnemaspis limayei* sp. nov., *Cnemaspis ajijae* sp. nov., *Cnemaspis amboliensis* sp. nov., *Cnemaspis mahabali* sp. nov.

**Citation:** Sayyed A, Pyron RA, Dileepkumar R. 2018. Four new species of the genus *Cnemaspis* Strauch, (Sauria: Gekkonidae) from the northern Western Ghats, India. *Amphibian & Reptile Conservation* 12(2) [General Section]: 1–29 (e157).

**Copyright:** © 2018 Sayyed et al. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits unrestricted use for non-commercial and education purposes only, in any medium, provided the original author and the official and authorized publication sources are recognized and properly credited. The official and authorized publication credit sources, which will be duly enforced, are as follows: official journal title *Amphibian & Reptile Conservation*; official journal website <amphibian-reptile-conservation.org>.

**Received:** 18 December 2017; **Accepted:** 29 May 2018; **Published:** 24 August 2018

## Introduction

The genus *Cnemaspis* Strauch, 1887, is one of the most species-rich genera of the family Gekkonidae and is distributed from Africa to Southeast Asia. Despite their superficial morphological similarity, molecular phylogeny has shown that the genus *Cnemaspis* is not a monophyletic group (Gamble et al. 2012; Pyron et al. 2013). Because the type species *C. boulengerii* Strauch, 1887 is from Southeast Asia (Strauch 1887), South Asian and African members of the genus will probably require different generic names in future revisions. While a full-scale revision of the genus remains out of reach due to a lack of sampling, ongoing fieldwork in areas of high gecko diversity continues to yield apparently new species, which

must therefore be described under the name *Cnemaspis*. In addition to molecular phylogenetics, these descriptions are facilitated by a rich literature on morphological variation in the group.

The genus is characterized by slender digits, clawed, rarely dilated; two distal phalanges compressed, forming an angle with the basal portion of the digits, the lower surface with rows of plates; body more or less depressed, granular, or tubercular above; tail more or less cylindrical; pupils round; eyelid distinct all around the eye; males with or without pre-anal or femoral pores; a well-developed hypo-ischium, post-anal bones and sacs, and a reduced hyoid apparatus, with only one pair of basi-branchials; presence of three or four sternal ribs; interclavicles well developed and cruciform (in the Oriental

**Correspondence.** <sup>1</sup> amitsayyedsatara@gmail.com, <sup>2</sup> rpyron@colubroid.org, <sup>3</sup> dileepkamukumpuzha@gmail.com (Corresponding author)

species) or much reduced and with only very small transverse arms (in the African species); adhesive toe pads absent (in the Oriental species) or present (in the African species); leaf toes and paraphalanges absent (Smith 1933, 1935; Gamble et al. 2012).

The genus currently includes 135 recognized species (Uetz and Hošek 2017), 29 of which are known from India. However, the true diversity of the group is likely much higher throughout its range, and in India in particular. During our fieldwork in India, we identified several populations that varied from the 29 known species with respect to several of the characters described above. Subsequent molecular phylogenetic analyses revealed them to be distinct species, and also clarified species limits in related taxa. In this study we describe four new species of *Cnemaspis* from northern Western Ghats of Maharashtra State, India. We show that the proposed species are morphologically distinct from their Indian congeners. Further, we also provide a molecular phylogenetic analysis of *Cnemaspis* species from India based on mitochondrial 16S rRNA sequences.

## Materials and Methods

**Specimen collection and museum details:** Specimens of the four new species were collected by hand from different localities in Maharashtra State, India from February 2015 to December 2016. See Appendix and data sources for the details of specimens of the known species collected from parts of the Western Ghats for genetic analysis. The specimens were photographed in life, then euthanized (George 1973), fixed in formalin, and preserved in 70% ethyl alcohol. For the genetic analysis, a few of each species were preserved in absolute alcohol. All specimens used in this work were collected by Amit Sayed and Abhiit Nale. The materials referred to are deposited in the collection of the Bombay Natural History Society (BNHS), Mumbai, and in the collection of Zoological Survey of India (ZSI) Akurdi, Pune, Maharashtra, India.

During the study period we have collected 43 additional specimens for examination from several localities in Goa, Karnataka, and Maharashtra which are morphologically similar to *C. goaensis*; out of these, 12 specimens were used for the molecular work, including topotypes of *C. indraneildasii*, BNHS 2460 and BNHS 2461, collected from Gund, Uttara Kannada, Karnataka, and specimen no. BNHS 2462 and BNHS 2463, collected from Dandeli, Karnataka. Specimen no. CnKh 33, ChKh 34, CnKo 48, and CnKo 49, were collected from the human habitation at Kolhapur, district Maharashtra. Specimen no. CnInAr 1 and CnInAr 2 were collected from Agumbe road. Specimen no. CnInA 1 and CnInA 2 were collected near Agumbe, Shimoga district, Karnataka. We have examined 18 males and 13 females including BNHS 2460 and BNHS 2461, collected near the type locality of *C. indraneildasii*. Other than *C. indraneildasii* we encountered only *C. heteropholis* in the ranges of Gund and

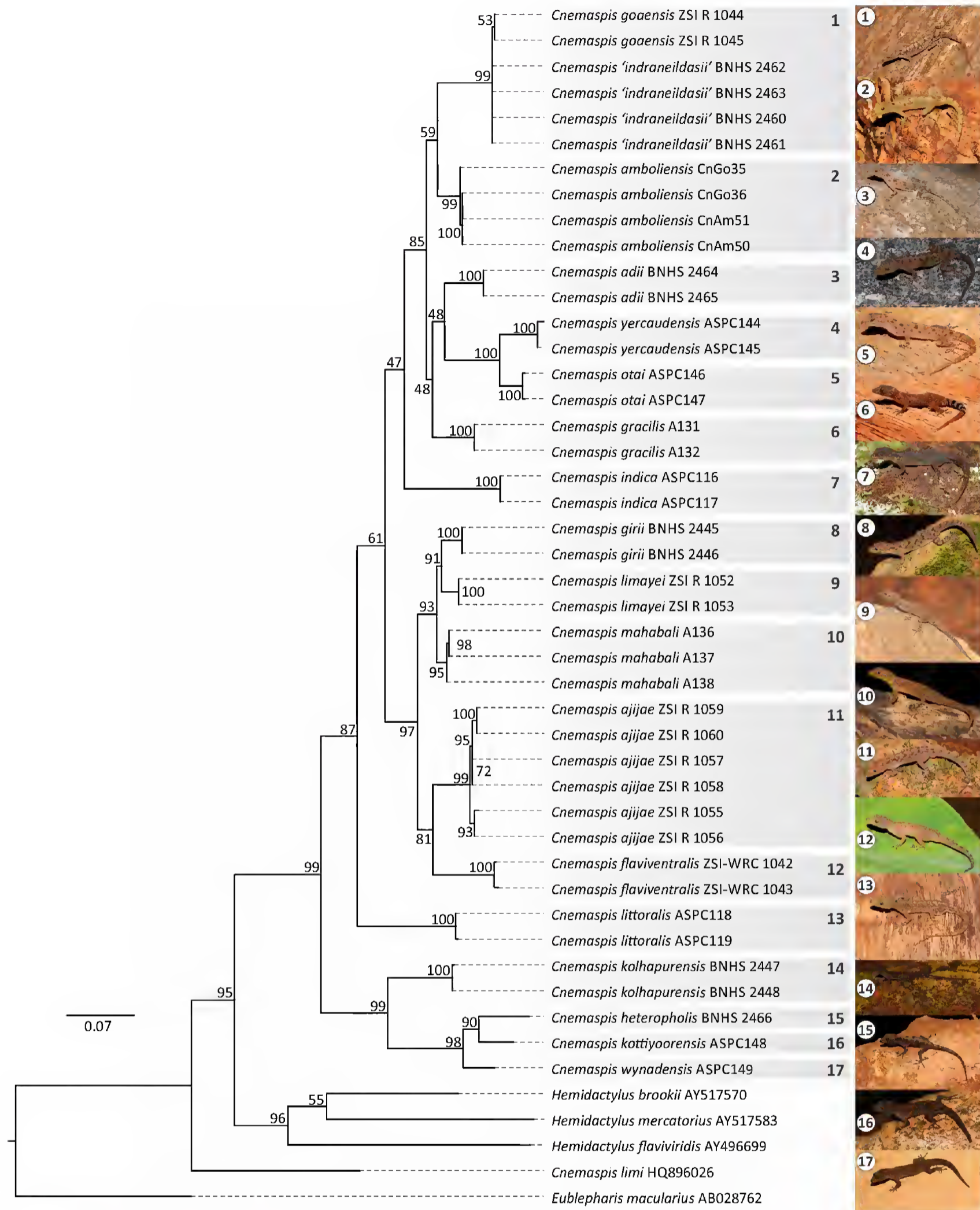
Agumbe, Karnataka. We also examined live specimens (not collected) of *C. goaensis* at Danoli, Sawantwadi Sindhudurg district, Maharashtra.

**Morphological study:** The following measurements were taken with a Yamayo digimatic caliper (to the nearest 0.1 mm): snout vent length (SVL; from tip of snout to vent), trunk length (TRL; distance from axilla to groin measured from posterior edge of forelimb insertion to anterior edge of hind limb insertion), trunk width (TW; maximum width of body), tail length (TL; from vent to tip of tail), tail width (TW; measured at widest point of tail), head length (HL; distance between retroarticular process of jaw and snout-tip), head width (HW; maximum width of head), head depth (HD; maximum depth of head, from occiput to underside of jaws), forearm length (FL; from base of palm to elbow), tibia length (TBL; knee to tarsal), eye to nares distance (E-N; distance between anterior most point of eye and nostril), eye snout to distance (E-S; distance between anterior most point of eye and tip of snout), eye to ear distance (E-E; distance from anterior edge of ear opening to posterior corner of eye), ear length (EL; maximum distance end to end of ear opening), distance between nares (IN; right to left nare), orbital diameter (OD; greatest diameter of orbit), and inter orbital snout distance (IO; narrowest distance greatest diameter between orbits on frontal bone). Meristic data recorded for all specimens were: the number of supralabial scales (SupraL), infralabial scales (InfraL), femoral pores (FPores), pre-anal pores (PaPores), and lamellae under digits of manus (MLam) and pes (PLam) for both left (L) and right (R) sides (lamellae counts taken from the scale just behind claw to first interphalangeal joint excluding large scancers), as well as scales across the belly between the lowest rows of dorsal scales (MVS), spine like tubercles (Sptub), and lamellae under IVth digit of pes (Lamp IVth). Scale counts and external observations of morphology were made using a Leica stereo microscope. For the geographical coordinates, altitude, and for temperature readings, we used a Kestrel 4500 receiver.

**Genetic analysis:** Muscle tissue was collected from 33 fresh specimens. DNA extraction, PCR amplification, and sequencing protocols follow Sayed et al. (2016). Sequences were edited in Geneious (Biomatters Ltd.) and analyzed with the BLAST tool (Altschul et al. 1990) for similar sequences in the NCBI (www.ncbi.gov) database. These sequences have been deposited in GenBank (accession numbers provided in Table 7). Sequences were included in the genetic data from Sayed et al. (2016). We included *Eublepharis* (Family Eublepharidae), *Hemidactylus*, and SE Asian *Cnemaspis* as outgroups.

Gene sequences were aligned using MUSCLE (Edgar 2004) under the default settings. The best-fit nucleotide substitution model was selected from 56 models available in PhyML (Guindon et al. 2010) using TOPALi v2 (Milne et al. 2008) based on minimum Bayesian Infor-

## Four new species of the genus *Cnemaspis*

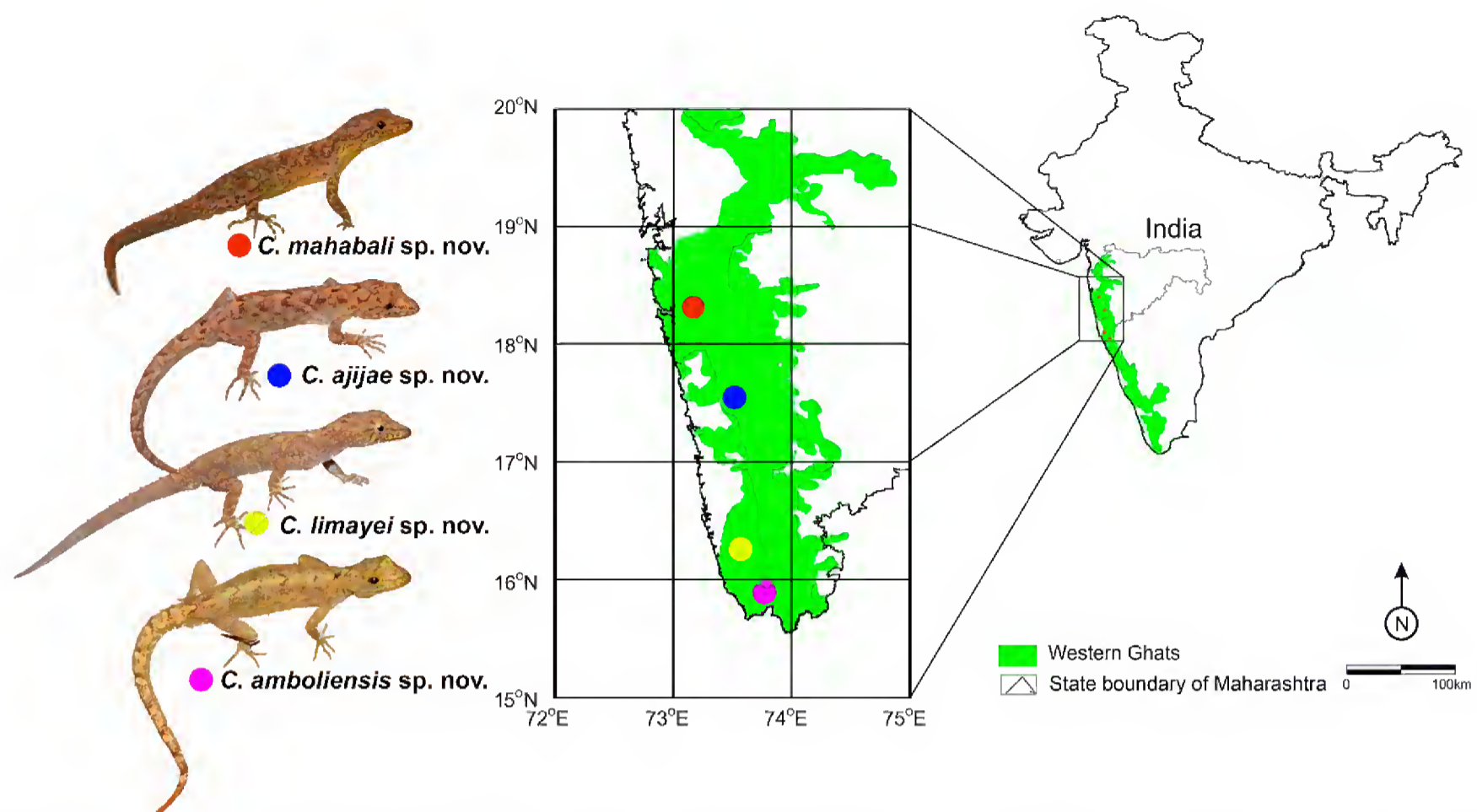


**Fig. 1.** Maximum likelihood tree of mitochondrial 16S rRNA gene. *Eublepharis macularius* is used as an out-group. Values along the node are percent bootstraps for 1,000 bootstrap iterations.

mation Criterion (BIC) value (Schwarz 1978; Nei and Kumar 2000). The best model was used to perform maximum likelihood (ML) analysis using PhyML (Guindon et al. 2010). Reliability of the phylogenetic tree was estimated using bootstrap values run for 1,000 iterations. Phylogenetic tree was edited in FigTree v1.4.2 (Rambaut 2009). The ML tree is provided with bootstrap values converted to percentages. We also calculated K2P-corrected pairwise distances between sequences in MEGA 7 (Kumar et al. 2016).

## Results

In addition to the four apparently new species, topotypic *C. goaensis* and *C. indraneildasii* formed a monophyletic group (Fig. 1) with minimal genetic distances (Table 5). It is therefore likely that *C. indraneildasii* is a synonym of *C. goaensis*. However, pending further investigation, the taxonomic status of *C. indraneildasii* will be discussed elsewhere. According to our study, *C. goaensis* is widely distributed in the ranges of southern Maharashtra, Goa, and Karnataka, India. See Fig. 28 for the distribution.



**Fig. 2.** Map showing the type localities of four new species: *Cnemaspis limayei* sp. nov. indicated by yellow circle, *Cnemaspis ajijae* sp. nov. indicated by blue circle, *Cnemaspis amboliensis* sp. nov. indicated by pink circle, *Cnemaspis mahabali* sp. nov. indicated by red circle, locations in the northern Western Ghats, Maharashtra, India.

All four new species collected from parts of the northern Western Ghats Maharashtra, India (Fig. 2) form monophyletic groups distinct from the other known species of Western Ghats *Cnemaspis* for which we could obtain genetic data from topotypic material (Fig. 1). Pair-wise genetic distances are provided (Table 5). Genetic distance between *Cnemaspis* of the Western Ghats ranged from 2.7 to 21.0%. Since 16S rRNA has not been used in *Cnemaspis* for species delimitation, there is no comparative account of genetic divergence for delineating species based on this marker. However, for other taxa like frogs of the genus *Indirana*, Dahanukar et al. (2016) showed a genetic gap between 1.9–2.4% genetic divergence in 16S rRNA indicating that distance more than 2.4% were reliable for species delimitation. Based on the genetic and morphological divergence of the four populations, we diagnose them as follows.

## Systematics

### *Cnemaspis limayei* sp. nov. (Figs. 3–6)

urn:lsid:zoobank.org:act:BBD5A08D-AEB2-4153-976B-ACCA9B3880C3

**Holotype:** BNHS 2454 (adult male); collected at night on 12 February, 2015 on a tree branch near a dry stream at Marutiwadi (16.221N, 73.475E; 132 m asl), near Phondaghat, Sindhudurg district, Maharashtra, India.

**Paratypes:** BNHS 2455 (female), ZSI-WRC R/1051, ZSI-WRC R/1052 (male) and ZSI-WRC R/1053 (female); same locality as holotype on the tree trunk and on the rocks of a dry stream, collected at the same place and time as holotype.

**Diagnosis:** Small-sized *Cnemaspis*, SVL less than 31

mm. Dorsal scales on trunk heterogeneous; granular, feebly keeled scales intermixed with large keeled depressed scales; conical and spine-like tubercles absent on flank; ventral scales smooth, larger than dorsal; pre-anal scales larger than ventral; 26–27 scales across the belly between lowest rows of dorsal scales; mental posteriorly pointed; two pairs of postmentals, primary larger than secondary, secondary postmentals touching first and second infralabials; nostrils in narrow contact with supralabial I; seven lamellae on digit I of the manus and 9–11 on digit IV, 7–8 on digit I of the pes, and 10–12 on digit IV. Males with 4–5 femoral pores on each side, pre-anal pores absent. Tail base visibly swollen, median sub-caudal scales not enlarged; one triangular, slightly keeled post-anal, very small tubercles along each side present in both sexes; broadly acute, prominent tubercles with small keeled scales dorsally on tail.

**Description of Holotype:** BNHS 2454 (adult male); has an entire, original tail (Fig. 4a, b). SVL 29.72 mm; head short (HL/SVL = 0.13), wide (HW/HL = 1.0), not strongly depressed (HD/HL = 0.63), distinct from elongate neck; canthus rostralis not prominent; loreal slightly inflated; snout slightly longer (E-S/HL = 0.77), longer than eye diameter (OD/E-S = 0.30); scales on snout and canthus rostralis large, keeled, slightly larger than those on forehead and interorbital; scales on forehead, interorbital, and occipital smaller, slightly keeled, granular (Fig. 6a); eye small (OD/HL = 0.23), pupil round, superciliaries not elongated; ear opening small, deep, oval shaped (0.07); eye to ear distance much greater than diameter of eye (E-E/OD = 2.0); rostral wider (1.12 mm) than deep (0.63 mm), slightly swollen, weakly divided; nostrils in narrow contact with supralabial I; rostral in

Four new species of the genus *Cnemaspis*

**Table 1.** Mensural and meristic data for the type series of *Cnemaspis limayei* sp. nov. Abbreviations as stated in Materials and Methods (\* = regenerated tail, \*\* = sub-adult, ? = broken finger, - = pores not present).

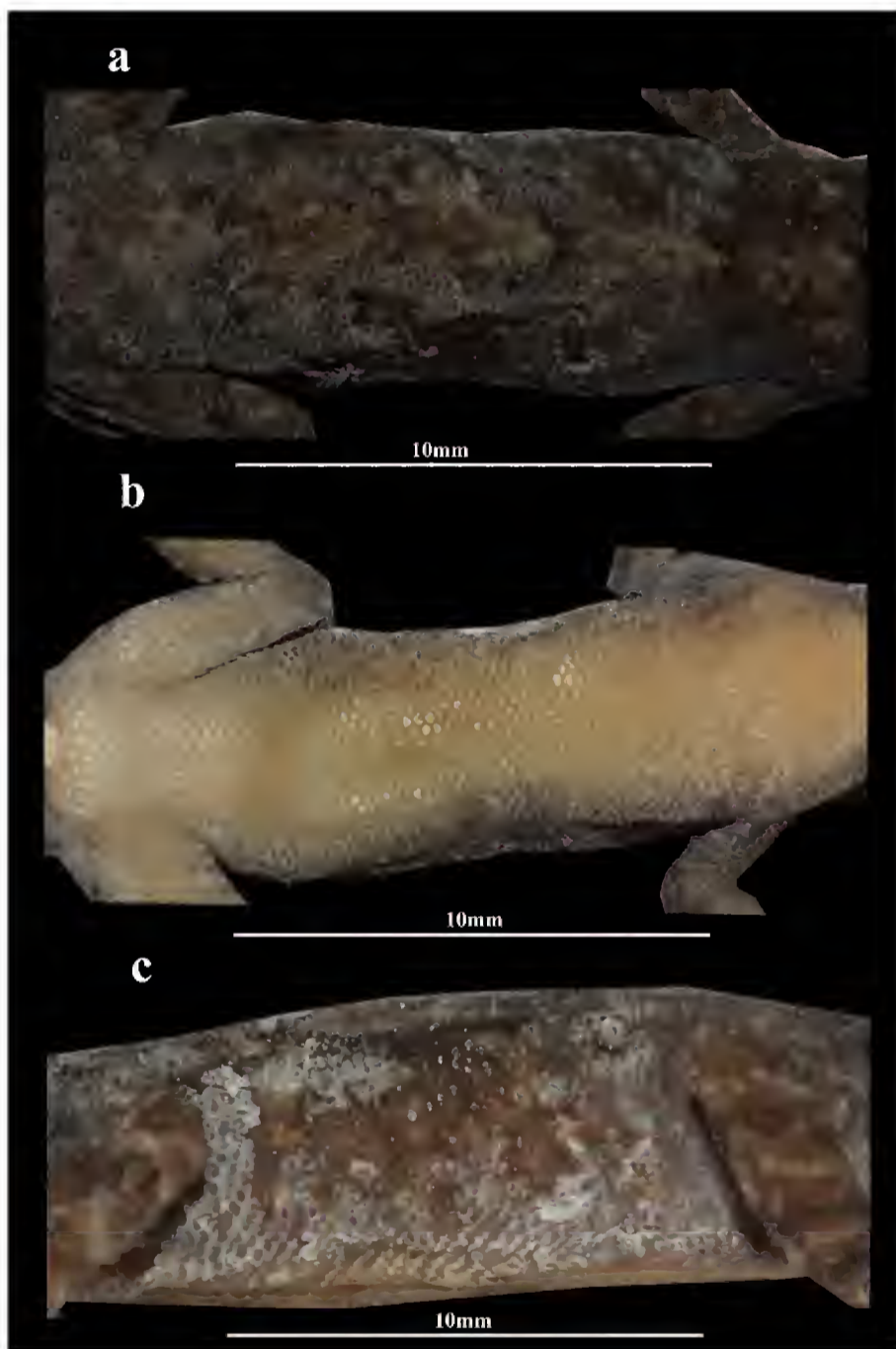
Measurement (mm)	Holotype		Paratypes		
	BNHS 2454	ZSI-WRC R/1052	ZSI-WRC R/1051	BNHS 2455	ZSI-WRC R/1053
	male	male*	male**	female	female
(SVL)	29.72	30.11	25.71	30.16	29.74
(TRL)	12.14	11.94	9.80	13.88	13.96
(TW)	5.45	5.47	4.53	6.23	6.37
(TL)	36.99	30.69	29.46	31.19	28.35
(TW)	2.82	2.69	2.07	2.69	2.42
(HL)	4.92	4.81	4.39	4.83	4.68
(HW)	5.00	5.09	4.96	5.07	5.06
(HD)	3.12	3.49	2.87	3.15	3.11
(FL)	3.77	3.71	3.54	3.93	3.81
(TBL)	4.37	4.43	4.26	4.84	4.71
(E-N)	3.27	3.50	3.19	3.38	3.25
(E-S)	3.83	4.17	3.87	4.02	4.15
(E-E)	2.43	2.73	2.35	2.83	2.86
(EL)	0.07	0.06	0.03	0.08	0.07
(IN)	0.94	0.82	0.80	1.00	0.99
(OD)	1.18	1.17	0.99	1.06	1.00
(IO)	3.28	3.93	3.60	3.63	3.73
HL/SVL	0.13	0.16	0.17	0.16	0.16
HW/SVL	0.17	0.17	0.19	0.17	0.17
HW/HL	1.02	1.06	1.13	1.05	1.08
E-S/HL	0.78	0.87	0.88	0.83	0.89
HD/HL	0.63	0.73	0.65	0.65	0.66
E-S/HW	0.76	0.82	0.78	0.79	0.82
OD/E-S	0.31	0.28	0.26	0.26	0.24
OD/HL	0.24	0.24	0.23	0.22	0.21
EL/HL	0.01	0.01	0.01	0.01	0.01
E-E/OD	2.06	2.33	2.37	2.67	2.86
TRL/SVL	0.41	0.40	0.38	0.46	0.47
FL/SVL	0.13	0.12	0.14	0.13	0.13
TBL/SVL	0.15	0.15	0.17	0.16	0.16
TL/SVL	1.24	1.01	1.14	1.03	0.95
MVS	27	26	26	27	26
SupraL	9/8	9/9	9/8	8/8	8/7
InfraL	8/8	8/8	8/8	7/8	8/7
FPores	5 on right, 4 on left	5 on right, 4 on left	4 on each side	-	-
MLam R	7-8-10-10-8	7-9-10-10-9	7-8-10-10-8	7-8-10-10-8	7-8-10-10-8
PLam R	7-8-10-10-10	8-9-11-10-?	7-8-10-11-10	7-8-10-11-10	8-8-10-10-10
MLam L	7-8-10-10-8	7-9-11-11-9	7-8-10-10-8	7-8-10-10-8	7-8-10-9-8
PLam L	7-8-11-10-11	8-9-12-12-11	7-8-12-11-10	7-8-11-10-10	7-8-11-10-10



**Fig. 3.** Holotype male (BNHS 2454) of *Cnemaspis limayei* sp. nov. in life.



**Fig. 4.** (a) Dorsal and (b) ventral view of the full body of *Cnemaspis limayei* sp. nov. Holotype (BNHS 2454).



**Fig. 5 (above).** (a) Dorsal, (b) ventral, and (c) lateral view of the mid body of *Cnemaspis limayei* sp. nov. Holotype (BNHS 2454).

**Fig. 6 (right).** (a) Dorsal, (b) ventral, and (c) lateral view of the head, (d) ventral view of right manus, (e) ventral view of right pes, and (f) the lower body of *Cnemaspis limayei* sp. nov. Holotype (BNHS 2454).

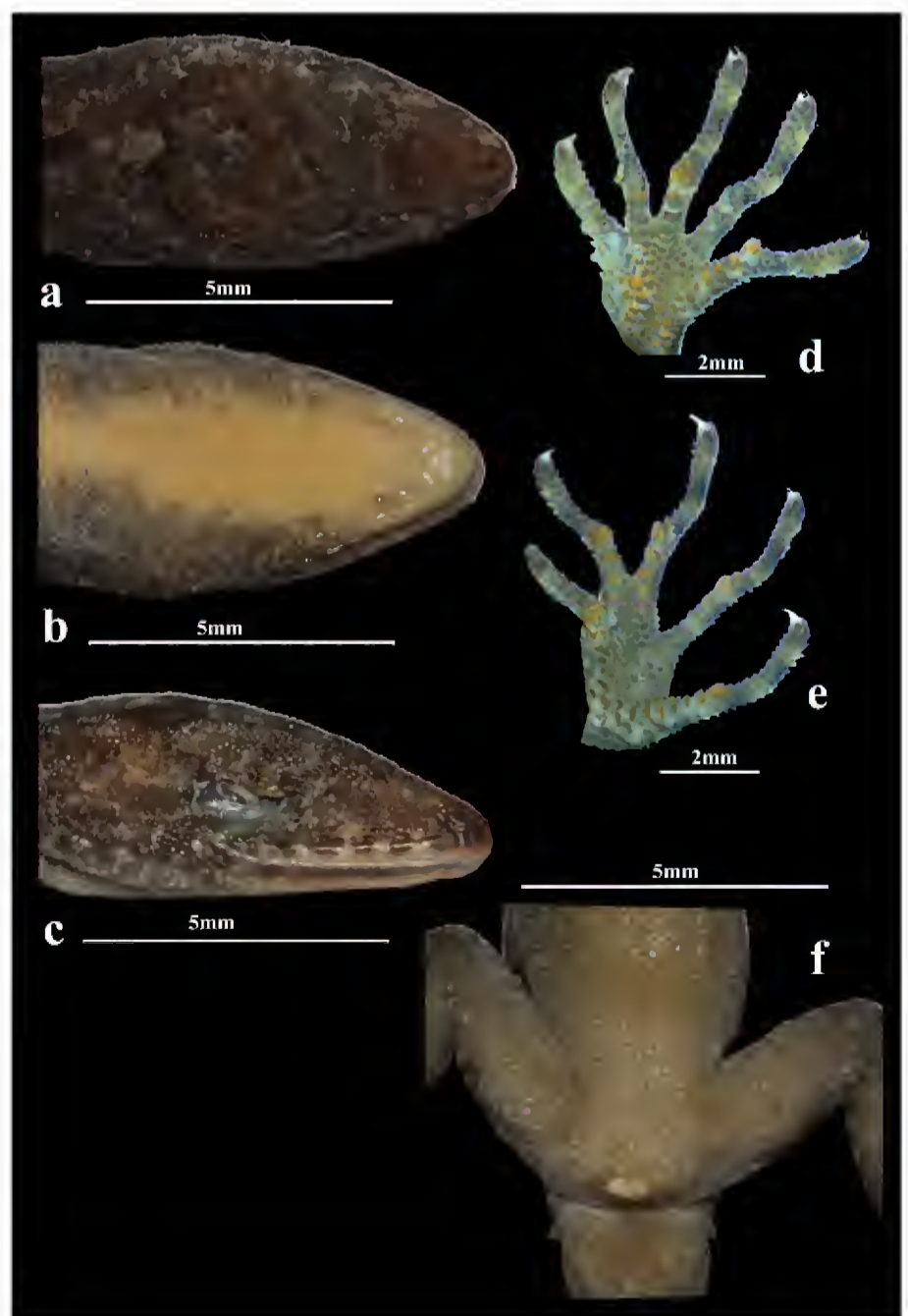




Fig. 7. Habitat of *Cnemaspis limayei* sp. nov.

contact with supralabial I; single row of scales separates orbit from supralabials; mental triangular, wider (1.43 mm) than deep (1.06 mm), posteriorly pointed; two pairs of postmentals, primary larger than secondary, secondary postmentals touching first and second infralabials; single enlarged gular scale prevents posterior contact of left and right postmentals (Fig. 6b); infralabials bordered by row of elongated scales; supralabials to angle of jawline right, eight left; infralabials- eight left, eight right (Fig. 6c); body relatively slender, not elongate ( $TRL/SVL = 0.40$ ), without ventrolateral folds; dorsal scales on trunk heterogeneous, granular, feebly keeled intermixed with large keeled depressed scales (Fig. 5a); conical and spine-like tubercles absent on flank (Fig. 5c); ventral scales smooth, larger than dorsal, pre-anal scales larger than ventral; 27 scales across the belly between lowest rows of dorsal scales (Fig. 5b); pre-anal pores absent, five femoral pores on right, four on left side (Fig. 6f); fore and hind limbs relatively short, slender; forearm and tibia short ( $FL/SVL = 0.12$ ;  $TBL/SVL = 0.14$ ); interdigital webbing absent. Lamellae 7–8–10–10–8 (right manus, Fig. 6d), 7–8–10–10–10 (right pes, Fig. 6e), relative length of digits (measurements in mm): IV (3.09) > III (2.74) > V (2.65) > II (1.84) > I (1.36) (right manus), IV (3.95) > III (3.16) > V (3.14) > II (2.58) > I (1.61) (right pes); tail sub-cylindrical, longer than snout-vent length ( $TL/SVL = 1.22$ ), base visibly swollen, median sub-caudal scales not enlarged; triangular, slightly keeled post-anal, very small tubercles along each side present; broadly acute, prominent tubercles with small keeled scales on dorsal tail.

**Color in life (Fig. 3):** Dorsal body brown; asymmetrical black marks with yellow dots on head; yellow dots more on snout than head; pale brownish-black line from nasal to mid eye; supraciliaries yellow, alternatively black; iris orange with thin orange line bordering pupil; pupil circular, black; supralabials brown and yellow; lower jaw and ventral side of throat yellow; black “W” mark posteriorly yellow, present on basal part of head; black arrow-head shaped patch on nuchal; semicircular black marks, posteriorly yellow, present on dorsal vertebra to sacral vertebra; few yellow spots present on flank; fore and hindlimbs with brown background with pale yellow and black patches; ventral body whitish-yellow; tail dorsally brown, with irregular black patches, ventrally grayish.

**Color pattern in preservation (Fig. 4a, b):** Dorsum color changes in to brownish-grey, black marking on body faded; ventral body color turned in to faded yellow; ventral head color changes in to yellow with scattered grey patches; ventral side of limbs and tail turned in to grey.

**Variation:** Adult specimens range in the type series size 29 to 30.16 mm (Table 1). All paratypes resemble the holotype in most respects except for the following characters: 9–11 lamellae under fourth digit of manus, 7–8 lamellae under first digit of pes and 10–12 under fourth digit of pes. ZSI-WRC R/1051 male has four femoral pores on each side.

**Etymology:** Specific epithet is a patronym in honor of Mr. Sunil. B. Limaye, Chief Conservator of Forests (Wildlife) Pune.

**Common name:** Limaye’s Day Gecko

**Natural history:** This is a nocturnal species found active on the tree trunk above 1–3 meters above ground, on the rock bed of a dried stream surrounded by forest (Fig. 7). Individuals were also observed (not collected) on the walls of houses made of mud and on compound wall structures of stone in Marutiwadi village. The population of this species was not dense at the locality and nearby area where the type series were collected. Gravid females were observed in the months of October and November at the study area. The types were found sympatrically with *Hemidactylus* sp., *Eutropis* cf. *macularia*, *Ahaetulla nasuta*, and *Amphiesma beddomei* in the same habitat.

**Distribution:** This species is currently known only from the type locality at Marutiwadi (16.221N, 73.475E; 132 m asl), near Phondaghat, Sindhudurg district, Maharashtra, India (Fig. 2).

**Remarks:** *Cnemaspis limayei* is distinguished from *C. girii* and *C. flaviventralis* by the absence of conical and spine-like tubercles on flank, having more femoral pores, and pre-cloacal scales larger than ventral body scales

(Table 6). Additionally, *C. girii* and *C. flaviventralis* are reported from higher elevations (Mirza et al. 2014; Sayyed et al. 2016), whereas *C. limayei* is reported at lower elevations ~132 m asl. In this study we did not observe *C. girii* anywhere except from the Kaas plateau and Chalkewadi plateau, Satara district, Maharashtra, India, suggesting it is endemic to Satara.

**Comparison:** *Cnemaspis limayei* sp. nov. can be separated from all its Indian congeners based on a combination of characters including: SVL 30.2 mm maximum in adults (vs. SVL 61.0 mm in *C. anaikattiensis*, 50.6 mm in *C. beddomei*, 45.1 mm in *C. heteropholis*, 41.7 mm in *C. kottiyooorensis*, 42.3 mm in *C. nilagirica*, and 42.7 mm in *C. sisparensis*); femoral pores present in males (vs. absent in *C. assamensis*, *C. beddomei*, *C. nairi*, and *C. ornata*); 4–5 femoral pores on each side (vs. six in *C. heteropholis*, 5–15 in *C. jerdonii*, 15–18 in *C. littoralis*, and 7–8 in *C. sisparensis*); spine-like tubercles absent on flank (vs. present in *C. assamensis*, *C. gracilis*, *C. indraneildasii*, *C. monticola*, *C. mysoriensis*, *C. nilagirica*, and *C. tropidogaster*); pre-anal pores absent (vs. present in *C. adii*, *C. andersonii*, *C. australis*, *C. beddomei*, *C. goaensis*, *C. gracilis*, *C. monticola*, *C. nairi*, *C. ornata*, *C. otai*, *C. tropidogaster*, *C. wicksii*, and *C. yercaudensis*); median sub-caudal scales not enlarged (vs. enlarged in *C. adii*, *C. australis*, *C. indica*, *C. littoralis*, *C. sisparensis*, and *C. wynadensis*); lamellae under fourth digit of pes 10–12 (vs. 12 in *C. indraneildasii* and 20–21 in *C. kottiyooorensis*); dorsal scales on trunk heterogeneous (vs. homogeneous in *C. adii*, *C. boiei*, *C. indica*, *C. jerdonii*, *C. kolhapurensis*, *C. littoralis*, *C. mysoriensis*, *C. nilagirica*, and *C. wynadensis*); midventral scales 26–27 (vs. 20–22 in *C. heteropholis*); two pairs of postmentals (vs. three pairs in *C. anaikattiensis*); supralabials to angle of jaws 7–9, broadly acute shape, small tubercles intermixed with small keeled scales on tail (vs. supralabials to angle of jaws six, dorsal scales on tail granular and smooth in *C. kottiyooorensis*).

The new species is similar in general appearance to *Cnemaspis girii* but differs by absence of conical tubercles on flank (vs. conical tubercles present on flank); forehead, interorbital, and occipital with smaller slightly keeled granular scales, larger tubercles not present (vs. forehead and interorbital region, occipital and temporal region with much smaller, unkeeled, granular scales intermixed with larger tubercles); pre-cloacal scales larger than ventral body scales (vs. pre-cloacal scales and ventral body scales are equal); males with 4–5 femoral pores on each side (vs. males with four femoral pores on each side); nine supralabials to angle of jaws (vs. eight supralabials to angle of jaws); maximum SVL 31 (vs. maximum SVL 35 mm); 10–12 lamellae under fourth digit of pes (vs. 17–20) (Table 6); from *C. flaviventralis* by having SVL less than 31 mm (vs. maximum SVL 37 mm); conical and spine-like tubercles absent on flank (vs. large keeled conical tubercles present on flanks); 26–27 mid-

ventrals (vs. 28–29 midventrals) (Table 6); two pairs of postmentals (vs. three pairs of postmentals); males with 4–5 femoral pores on each side (vs. males with three femoral pores on each side); pre-cloacal scales larger than ventral body scales (vs. pre-cloacal scales same as ventral body scales).

### ***Cnemaspis ajijae* sp. nov. (Figs. 8–11)**

urn:lsid:zoobank.org:act:A88992C2-BBC4-4A32-80C9-6683C11A9252

**Holotype:** BNHS 2456, adult male; collected by hand at night on 15 November, 2015, on a tree trunk beside a dry stream surrounded by dense forest, at Mahabaleshwar (17.545N, 73.403E; 1,377 m asl), Satara district, Maharashtra, India.

**Paratypes:** ZSI-WRC R/1054, ZSI-WRC R/1056 (male), and ZSI-WRC R/1055 (female) share the same data and same locality as the holotype and ZSI-WRC R/1057 (male) and ZSI-WRC R/1058 (female), in the dense forest at Mahabaleshwar (17.553N, 73.391E; 1,291 m asl), Satara district, Maharashtra, India, collected on 15 November, 2015; ZSI-WRC R/1059, ZSI-WRC R/1060 (male), and BNHS 2457 (female), Panchgani (17.554N, 73.483E; 1,323 m asl), Satara district, Maharashtra, India, collected on 29 October, 2015.

**Diagnosis:** A medium sized *Cnemaspis*, SVL less than 37 mm. Dorsal scales on trunk heterogeneous; granular, keeled scales intermixed with large keeled, depressed scales; conical and spine-like tubercles absent on flank; ventral scales larger than dorsal, smooth; 29–30 scales across belly between lowest rows of dorsal scales; three pairs of postmentals, primary larger than others, secondary postmentals touching first and second infralabials; third chinshield smaller than second; 7–8 lamellae on digit I of manus and 9–12 on digit IV, 7–8 on digit I of pes and 10–13 on digit IV; males with three or four femoral pores, pre-anal pore absent; median row of sub-caudals smooth, imbricate not enlarged; small triangular tubercles along each side present in both sexes; very small acute, prominent tubercles with small keeled scales on dorsal tail.

**Description of Holotype:** BNHS 2456 (adult male); has an entire, original tail (Fig. 9a, b). SVL 29.80 mm; head moderately short (HL/SVL = 0.17), wide (HW/HL = 1.03), not strongly depressed (HD/HL = 0.61), distinct from elongate neck; canthus rostralis not prominent; snout slightly longer (E-S/HL = 0.75), much longer than eye diameter (OD/E-S = 0.30); weakly keeled, granular scales on snout and on maxilla; scales on forehead and on interorbital granular, smaller than snout (Fig. 11a); eye fairly small (OD/HL = 0.23), pupil round; superciliaries not elongated; ear opening deep, circular, small (EL/HL = 0.02); eye to ear distance much greater than diameter of eyes (E-E/OD = 2.43); rostral wider (1.51 mm) than

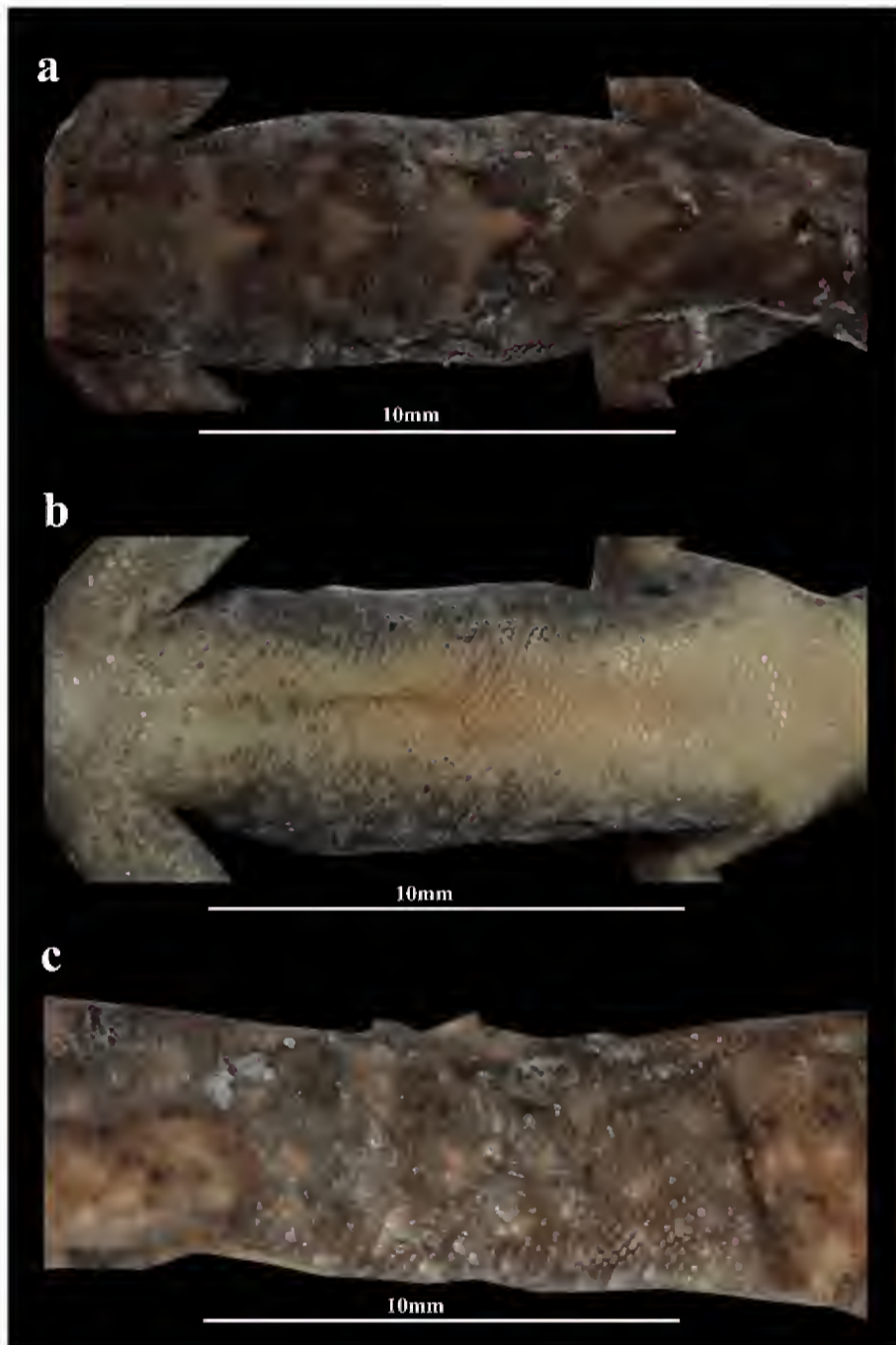




**Fig. 8.** Holotype male (BNHS 2456) of *Cnemaspis ajijae* sp. nov. in life.

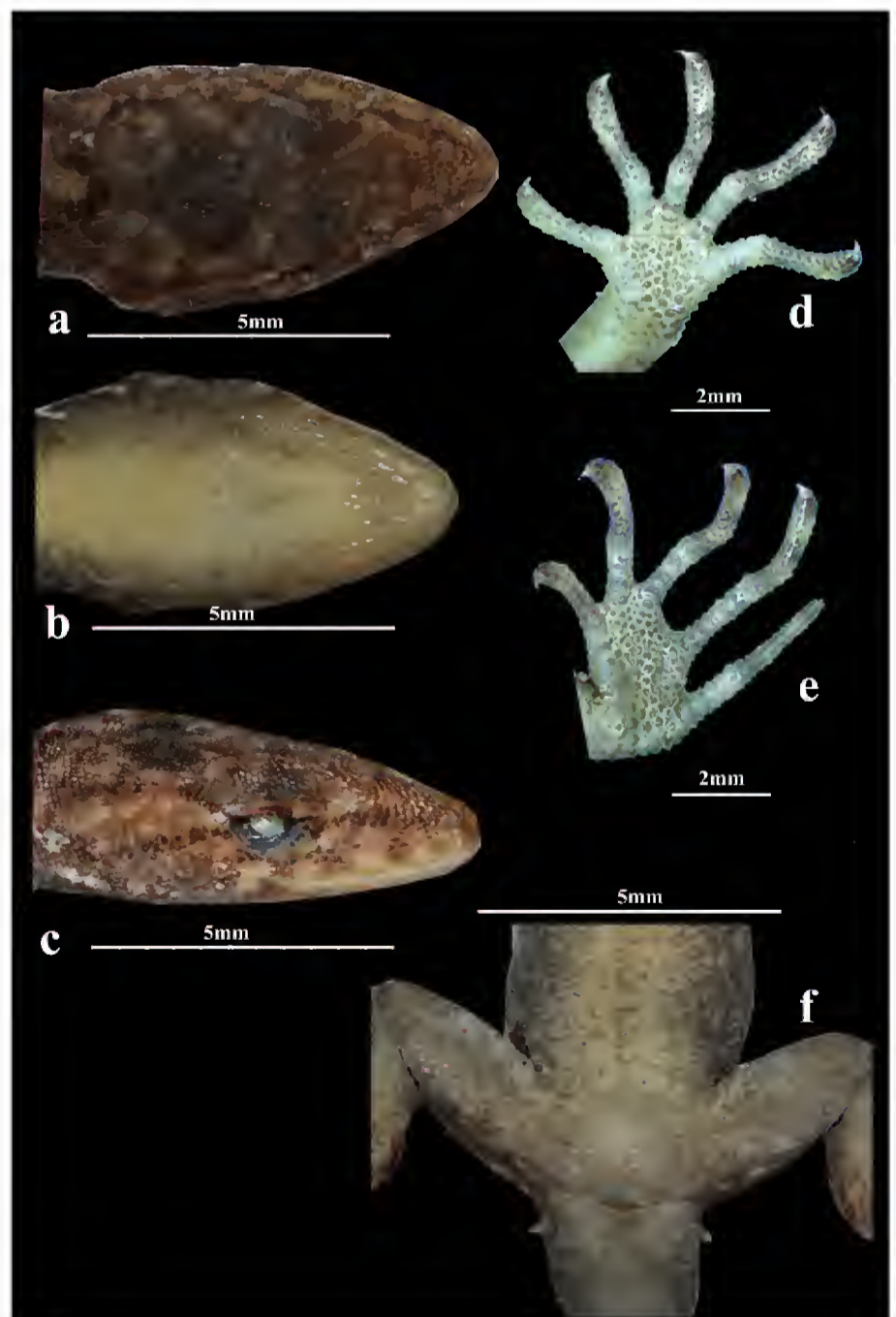


**Fig. 9.** (a) Dorsal and (b) ventral view of the full body of *Cnemaspis ajijae* sp. nov. Holotype male (BNHS 2456).



**Fig. 10 (above).** Dorsal, (b) ventral, and (c) lateral view of the mid body of *Cnemaspis ajijae* sp. nov. Holotype (BNHS 2456).

**Fig. 11 (right).** (a) Dorsal, (b) ventral, and (c) lateral view of the head, (d) ventral view of right manus, (e) ventral view of right pes, and (f) the lower body of *Cnemaspis ajijae* sp. nov. Holotype (BNHS 2456).





**Fig. 12.** (a) Dense evergreen forest of Mahabaleshwar, (b) showing wall of lateritic plateau (tableland of Panchgani) and connected forest, habitat of *Cnemaspis ajijae* sp. nov.

deep (0.58 mm), slightly swollen, divided; nostrils not in contact with supralabial I; rostral in contact with supralabial I; two rows of scales separate orbit from supralabials; mental triangular, approximately equivalent (1.68 mm) as long (1.14 mm); three pairs of postmentals, primary larger than others, secondary postmentals touching to first and second infralabials, third chinshiled smaller than second; single enlarged gular scale prevents posterior contact of left and right postmentals (Fig. 11b); infralabials bordered by a row of small elongated scales; supralabials to angle of jaw- seven right, eight left; infralabials- seven left, seven right (Fig. 11c); body relatively slender, not elongate ( $TRL/SVL = 0.43$ ) without ventrolateral folds; dorsal scales on trunk heterogeneous, granular, keeled, intermixed with large keeled depressed scales (Fig. 10a); conical and spine-like tubercles absent on flank (Fig. 10c); ventral scales smooth, larger than dorsal; midbody scales across belly between the lowest rows of dorsal scales 29 (Fig. 10b); three femoral pores on each side, pre-anal pores absent (Fig. 11f); fore and hindlimbs relatively short, slender; forearm and tibia short ( $FL/SVL = 0.14$ ;  $TBL/SVL = 0.14$ ); interdigital webbing absent; lamellae 7–8–10–10–9 (right manus, Fig. 11d), 7–8–10–11–10 (right pes, Fig. 11e); relative length of digits (measurements in mm): IV (2.92) > V (2.63) > III (2.41) > II (2.16) > I (1.84) (right manus); IV (3.79) > V (3.30) > III (3.05) > II (2.85) > I (1.35) (right pes); tail sub-cylindrical, longer than snout-vent length

( $TL/SVL = 1.10$ ); tail base visibly swollen; triangular shape post-anal small keeled tubercles along each side present; median row of sub-caudals smooth, imbricate, not enlarged; very small acute, prominent tubercles with small keeled scales on dorsal tail.

**Color in life (Fig. 8):** Dorsum ground color grey; heart-shaped mark on the dorsal head; semicircular dark-black mark on the nape; vertically elongate black mark on cervical; black and brown chevron marks scattered on the dorsal vertebrae with light orange patches; brown and orange spots on flanks; supraciliaries brownish; pupil circular, black surrounded by yellowish-orange color; single brownish line with black scales from nasal to mid eye region, similar line runs from the posterior eye to ear opening; supralabials barred alternately with brown and light orange; throat and ventrum of body white; ventral view of lower and upper arm grey; original part of the tail brown with marks of black transverse lines; ventral part of the tail grayish.

**Color pattern in alcohol preservation (Fig. 9a, b):** Dorsum brown and black marks in life faded, turned in to brown, ventral body color turned in to yellowish-grey with scattered grey patches and ventral tail became dark-grey.

**Variation:** Adult specimens range in the type series size 28–36.23 mm (Table 2). All paratypes resemble the holotype in most respects except for the following characters: 7–8 lamellae under first digit of manus, 9–12 under fourth digit of manus, 7–8 lamellae under first digit of pes, and 10–13 under fourth digit of pes. Holotype BNHS 2456 (male) has three femoral pores each side, ZSI-WRC R/1054, ZSI-WRC R/1059, ZSI-WRC R/1056, and ZSI-WRC R/1057 (males) have four femoral pores each side, ZSI-WRC R/1060 has four on right, three on left. 7–8 supralabials to the angle of jaw, 7–8 infralabials to the angle of jaw, and two pairs of postmentals in ZSI-WRC R/1056 and ZSI-WRC R/1058.

**Etymology:** Specific epithet is a patronym in honor of Mrs. Ajija Sayyed, mother of the first author.

**Common name:** Ajija's Day Gecko.

**Natural history:** This species can be found at night in dense evergreen forest, as well as in the human habitation in Mahabaleshwar. The type series (BNHS 2456 male and ZSI-WRC R/1055 female) were collected beside a dry stream surrounded by dense forest (Fig. 12a), specimens (ZSI-WRC R/1060 male and ZSI-WRC R/1058 female) on the wall of bus stand in Mahabaleshwar, wall of lateritic plateau (tableland of Panchgani), and in the jungle area nearby the town of Panchgani (Fig. 12b). During this survey we observed several individuals of *Cnemaspis ajijae* at both localities. The types were found

## Four new species of the genus *Cnemaspis*

**Table 2.** Mensural and meristic data for the type series of *Cnemaspis ajijae* sp. nov. Abbreviations as stated in Materials and Methods (\* = regenerated tail, \*\* = sub-adult, - = pores not present).

Measurement (mm)	Holotype			Paratypes					
	BNHS 2456	ZSI-WRC R/1054	ZSI-WRC R/1055	BNHS 2457	ZSI-WRC R/1058	ZSI-WRC R/1059	ZSI-WRC R/1060	ZSI-WRC R/1056	ZSI-WRC R/1057
	male	male	female*	female	female*	male	male	male**	male
(SVL)	29.80	28.68	36.23	35.24	32.79	28.35	28.93	24.38	29.07
(TRL)	12.92	12.48	16.02	16.66	16.97	10.68	11.18	11.15	12.56
(TW)	5.92	6.68	8.09	9.14	7.06	5.62	5.84	5.44	6.30
(TL)	32.89	31.56	23.31	36.51	25.02	26.66	30.69	25.73	32.70
(TW)	2.48	3.42	3.01	3.62	3.14	3.49	2.89	1.64	2.97
(HL)	5.27	5.08	5.36	5.85	6.42	5.23	5.10	4.76	5.20
(HW)	5.48	5.68	5.81	5.98	5.75	5.38	5.50	4.64	5.68
(HD)	3.23	3.66	3.70	3.96	4.21	3.18	3.21	2.65	3.58
(FL)	4.27	4.21	4.21	4.62	4.83	4.17	4.22	3.70	4.23
(TBL)	4.27	4.51	4.52	5.11	5.00	4.29	4.32	4.13	4.32
(E-N)	3.40	3.89	3.99	3.98	4.21	3.08	3.56	3.12	3.66
(E-S)	3.98	4.75	4.59	4.74	5.21	4.06	4.10	4.18	4.41
(E-E)	2.99	3.02	3.01	3.14	3.11	2.94	2.82	2.17	2.74
(EL)	0.12	0.10	0.11	0.12	0.11	0.10	0.09	0.07	0.10
(IN)	1.05	1.08	1.07	1.08	1.02	0.92	0.97	0.90	0.93
(OD)	1.23	1.30	1.02	1.13	1.25	1.12	1.03	0.92	1.10
(IO)	3.90	3.62	3.76	4.01	3.73	3.12	3.43	2.50	3.61
HL/SVL	0.18	0.18	0.15	0.17	0.19	0.18	0.18	0.20	0.18
HW/SVL	0.18	0.19	0.16	0.17	0.17	0.19	0.19	0.19	0.19
HW/HL	1.04	1.11	1.08	1.02	0.90	1.03	1.07	0.97	1.09
E-S/HL	0.75	0.93	0.86	0.81	0.81	0.77	0.80	0.88	0.85
HD/HL	0.61	0.72	0.69	0.68	0.65	0.60	0.63	0.56	0.69
E-S/HW	0.73	0.84	0.79	0.79	0.90	0.75	0.74	0.90	0.77
OD/E-S	0.31	0.27	0.22	0.24	0.24	0.27	0.25	0.22	0.25
OD/HL	0.23	0.25	0.19	0.19	0.19	0.21	0.20	0.19	0.21
EL/HL	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01
E-E/OD	2.43	2.32	2.95	2.78	2.48	2.62	2.73	2.36	2.49
TRL/SVL	0.43	0.44	0.44	0.47	0.52	0.38	0.39	0.45	0.43
FL/SVL	0.14	0.15	0.12	0.13	0.15	0.15	0.15	0.15	0.14
TBL/SVL	0.14	0.16	0.12	0.15	0.15	0.15	0.15	0.17	0.15
TL/SVL	1.10	1.10	0.64	1.04	0.76	0.94	1.06	1.06	1.10
MVS	29	30	29	30	29	29	30	29	29
SupraL	7/8	8/8	8/8	8/8	7/7	8/8	8/8	8/8	8/8
InfraL	7/7	8/8	7/7	7/7	7/7	8/8	7/7	7/7	8/7
FPores	3 on each side	4 on each side	-	-	-	4 on each side	4 on right, 3 on left	4 on each side	4 on each side
MLam R	7-8-10-10-9	8-10-12-12-10	7-9-11-10-8	7-9-11-11-9	7-8-11-10-10	7-9-12-12-10	8-9-12-11-9	7-8-10-9-9	7-8-10-9-8
PLam R	7-8-10-11-10	8-9-6?-13-13	7-8-11-11-11	7-9-11-11-10	7-8-11-11-10	8-9-13-12-13	8-9-12-12-12	7-8-10-10-11	7-8-11-10-10
MLam L	7-8-10-10-9	8-10-13-12-10	7-8-10-10-8	7-9-11-11-9	7-8-9-10-8	8-9-12-12-10	8-9-11-11-9	7-8-10-9-9	7-8-10-10-8
PLam L	7-8-10-10-10	8-9-13-13-13	7-8-11-11-11	7-9-12-11-11	7-8-10-10-11	8-9-13-13-13	8-9-13-12-12	7-8-12-11-10	7-8-11-11-10

sympatrically with *Hemidactylus* sp., *Trimeresurus malabaricus*, *Trimeresurus gramineus*, *Boiga trigonata*, *Lycodon aulicus*, and *L. travancoricus* in the same habitat where specimens BNHS 2456 (male), ZSI-WRC R/1054 (male), and ZSI-WRC R/1055 (female) were collected. At Panchgani, *Hemidactylus maculatus* and *Hemidactylus* sp. were observed at the same habitat where BNHS 2457 (female), ZSI-WRC R/1056 (male), and ZSI-WRC R/1057 (male) were collected.

**Distribution:** This species is seemingly abundant in Mahabaleshwar (17.545N, 73.403E; 1,377 m asl), (17.553N, 73.391E; 1,291 m asl), and in Panchgani (17.554N, 73.483E; 1,323 m asl), Satara district, Maharashtra, India. It is currently known only from a small area around the type locality. See Fig. 2 for the type locality of the species.

**Remarks:** *Cnemaspis ajijae* is distinguished from *C. girii* and from *C. flaviventralis* by several morphological characters. *C. ajijae* can easily be distinguished from *C. girii* by having maximum SVL 37 mm (vs. 35 mm); conical and spine-like tubercles absent on flank (vs. large keeled conical tubercles on flank); 29–30 midventrals (vs. 26–28 midventrals); three pairs of postmentals (vs. two pairs of postmentals); very small acute, prominent tubercles dorsally on tail (vs. large tubercles present on dorsal part of tail); from *C. flaviventralis* by absence of conical and spine-like tubercles on flank (vs. large keeled conical tubercles present on flanks); 29–30 midventrals (vs. 28–29); 7–8 supralabials (vs. 7–9); 10–13 lamellae on digit IV of pes (vs. 10–12); small tubercles on the tail (vs. large tubercles on the tail).

**Comparison:** *Cnemaspis ajijae* can be separated from all its Indian congeners based on a combination of characters including: SVL 37 mm maximum in adults (vs. SVL 61 mm in *C. anaikattiensis*, 50.6 mm in *C. beddomei*, 45.1 mm in *C. heteropholis*, 42.3 mm in *C. nilagirica*, and 42.7 mm in *C. sisparensis*); males with femoral pores (vs. absent in *C. assamensis*, *C. beddomei*, *C. nairi*, and *C. ornata*); males with 3–4 femoral pores (vs. six in *C. heteropholis*, 5–15 in *C. jerdonii*, and 15–18 in *C. littoralis*); pre-anal pores absent in males (vs. present in *C. adii*, *C. andersonii*, *C. australis*, *C. beddomei*, *C. goaensis*, *C. gracilis*, *C. monticola*, *C. nairi*, *C. ornata*, *C. otai*, *C. wicksii*, and *C. yercaudensis*); spine-like tubercles absent on flank (vs. present in *C. assamensis*, *C. goaensis*, *C. gracilis*, *C. monticola*, *C. nilagirica*, and *C. tropidogaster*); dorsal scales on trunk heterogeneous (vs. homogenous in *C. adii*, *C. boiei*, *C. indica*, *C. jerdonii*, *C. kolhapurensis*, *C. littoralis*, *C. mysoriensis*, *C. nilagirica*, *C. sisparensis*, and *C. wynadensis*); sub-caudal scales not enlarged (vs. enlarged in *C. kottiyooensis*, *C. monticola*, and *C. wynadensis*); 29–30 midventral scales (vs. 26–27 in *C. anaikattiensis*); dorsal scales on both fore and hind limbs are weakly carinate (vs. dorsal scales on both fore

and hind limbs smooth in *C. wicksii*); 10–13 lamellae on fourth digit of the pes (vs. 20–21 in *C. kottiyooensis*); nostril not in contact with supralabial (vs. nostril in contact with the first supralabial in *C. anaikattiensis*).

*Cnemaspis ajijae* can be distinguished from *C. indraneildasii* based on a combination of characters including: scales on flank heterogeneous (vs. flank mostly homogenous); spine-like tubercles absent on flank (vs. spine-like tubercles present on flanks); dorsal scales large (vs. small); 29–30 midventrals (vs. 20); nostrils not in contact with supralabial (vs. nostril connects first supralabial); dorsal scales on limbs weakly carinate (vs. not carinate); 7–8 supralabials to angle of jaw (vs. 8–9); very small acute shape, tubercles on the tail (vs. enlarged pointed tubercle); from *C. girii* by having maximum SVL 37 mm (vs. SVL less than 35 mm); conical and spine-like tubercles absent on flank (vs. large keeled conical tubercles on flank); 29–30 midventrals (vs. 26–28 midventrals) (Table 6); three pairs of postmentals (vs. two pairs of postmentals); very small acute, prominent tubercles dorsally on tail (vs. large tubercles present on dorsal part of tail); from *C. flaviventralis* by absence of conical and spine-like tubercles on flank (vs. large keeled conical tubercles present on flanks); 29–30 midventrals (vs. 28–29); 7–8 supralabials (vs. 7–9); 10–13 lamellae on digit IV pes (vs. 10–12) (Table 6); small tubercles on the tail (vs. large tubercles on the tail); from *C. limayei* by having maximum SVL 37 mm (vs. less than 31 mm); 29–30 midventrals (vs. 26–27); three pairs of postmentals (vs. two pairs of postmentals); males with three or four femoral pores (vs. 4–5 femoral pores) (Table 6).

### ***Cnemaspis amboliensis* sp. nov. (Figs. 13–18)**

urn:lsid:zoobank.org:act:6D80B074-DF22-478B-AD45-658640E80B6A

**Holotype:** BNHS 2458 (adult male); collected on 23 October, 2015 at Amboli (15.960 N, 73.999 E; 735 m asl), Sindhudurg district, Maharashtra, India.

**Paratypes:** BNHS 2459 (adult female), BNHS 2504, BNHS 2506, BNHS 2507, BNHS 2508, and BNHS 2505 (all male) have the same collection data as for the holotype, collected on tree trunks, rocks, inside walls of local houses, and on stone compound walls.

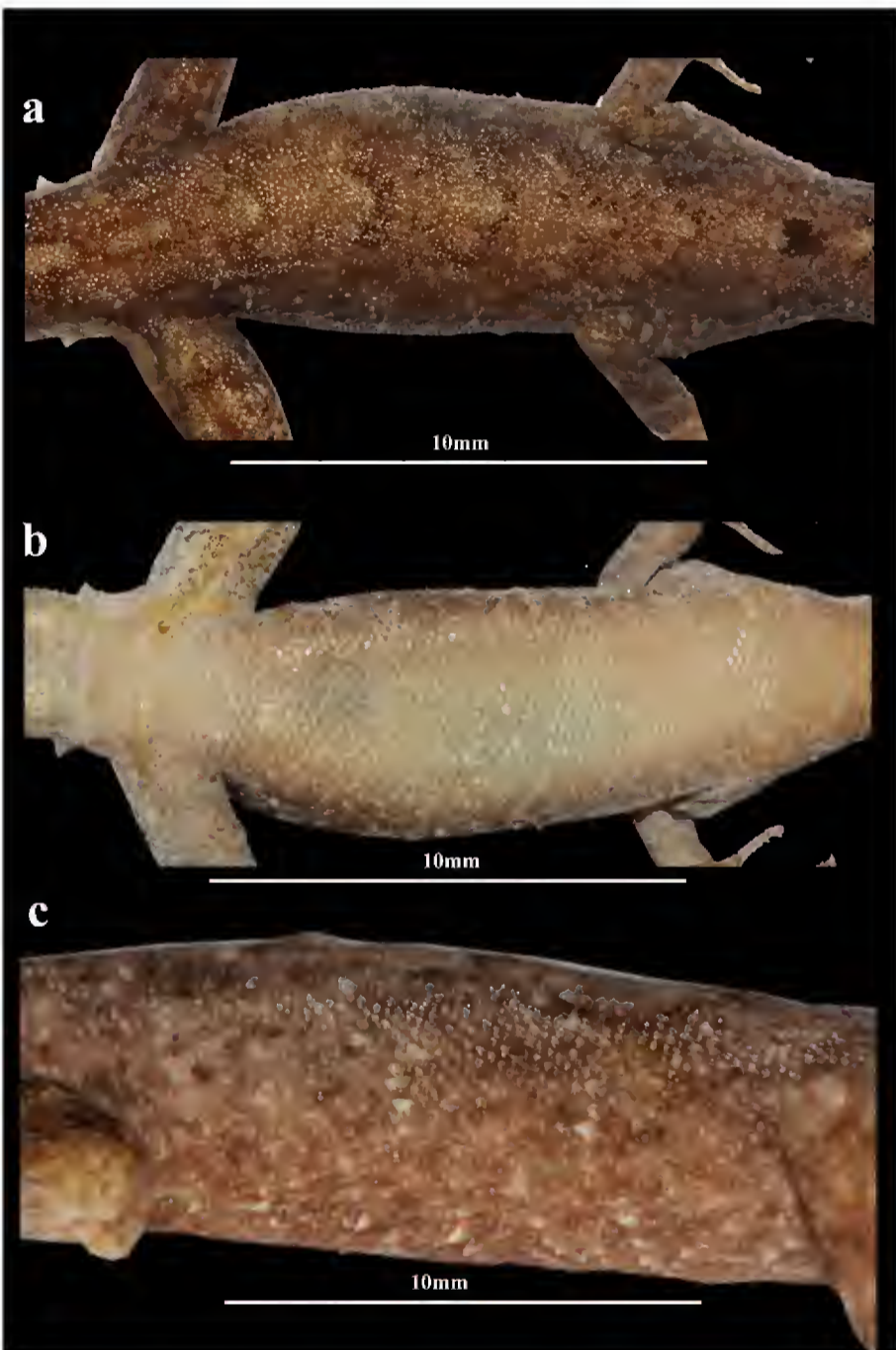
**Diagnosis:** Medium-sized day gecko, SVL less than 32 mm; dorsal scales on trunk heterogeneous; granular, keeled, small scales intermixed with some large keeled scales; some conical and spine-like tubercles on flank; ventral scales smooth, imbricate, larger than dorsal; 19–22 midbody scales across the belly; scales on snout feebly keeled; canthus rostralis and forehead granular, feebly keeled; rostral not swollen, medial groove absent; gular with carinate scales, anterior gular scales smooth; dorsal scales on forelimb and hindlimb tricarinate; tail sub-cylindrical, ventrally swollen, one small triangular post-anal spur along each side present in males; sub-cau-



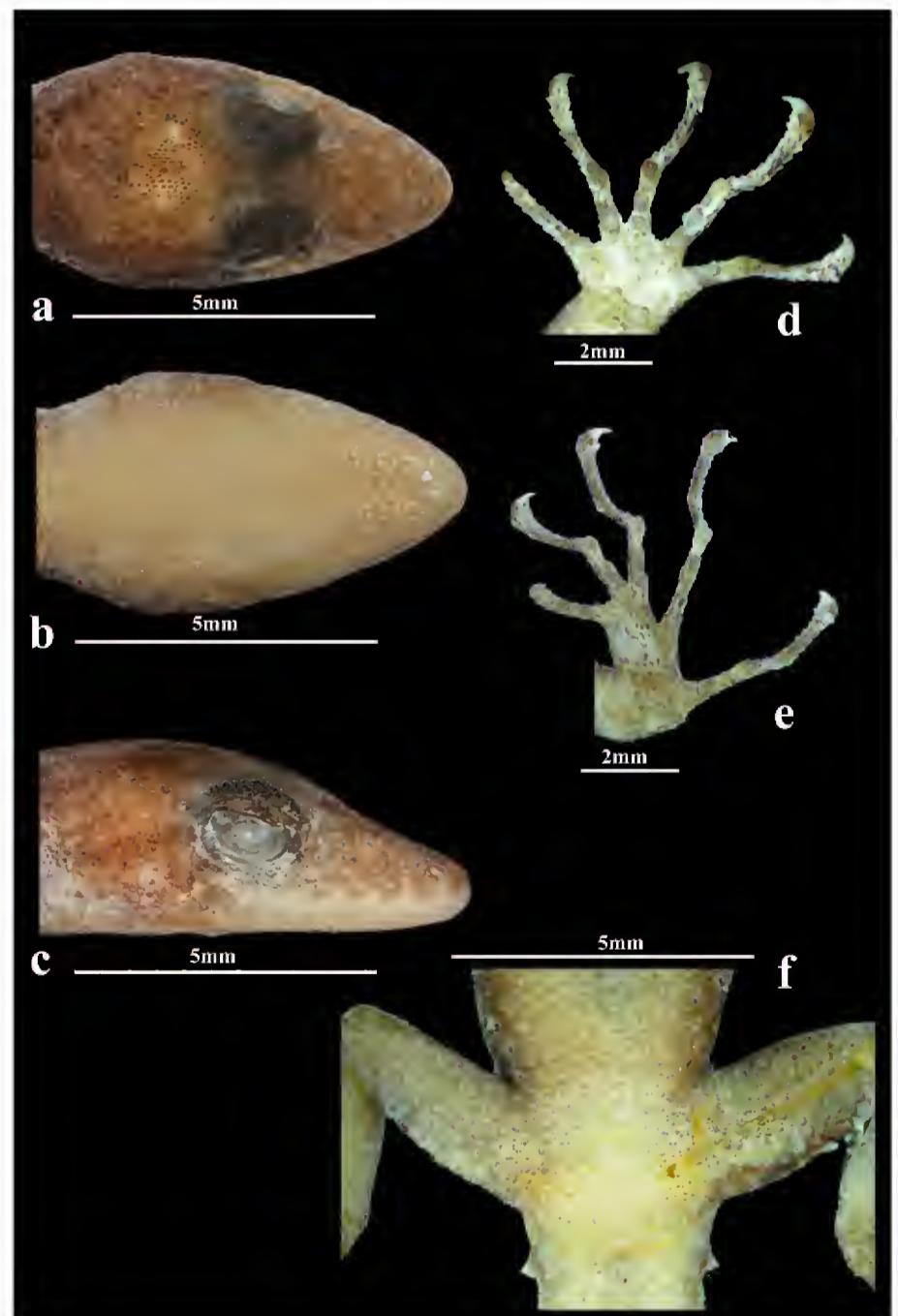
**Fig. 13.** Holotype male (BNHS 2458) of *Cnemaspis amboliensis* sp. nov. in life.



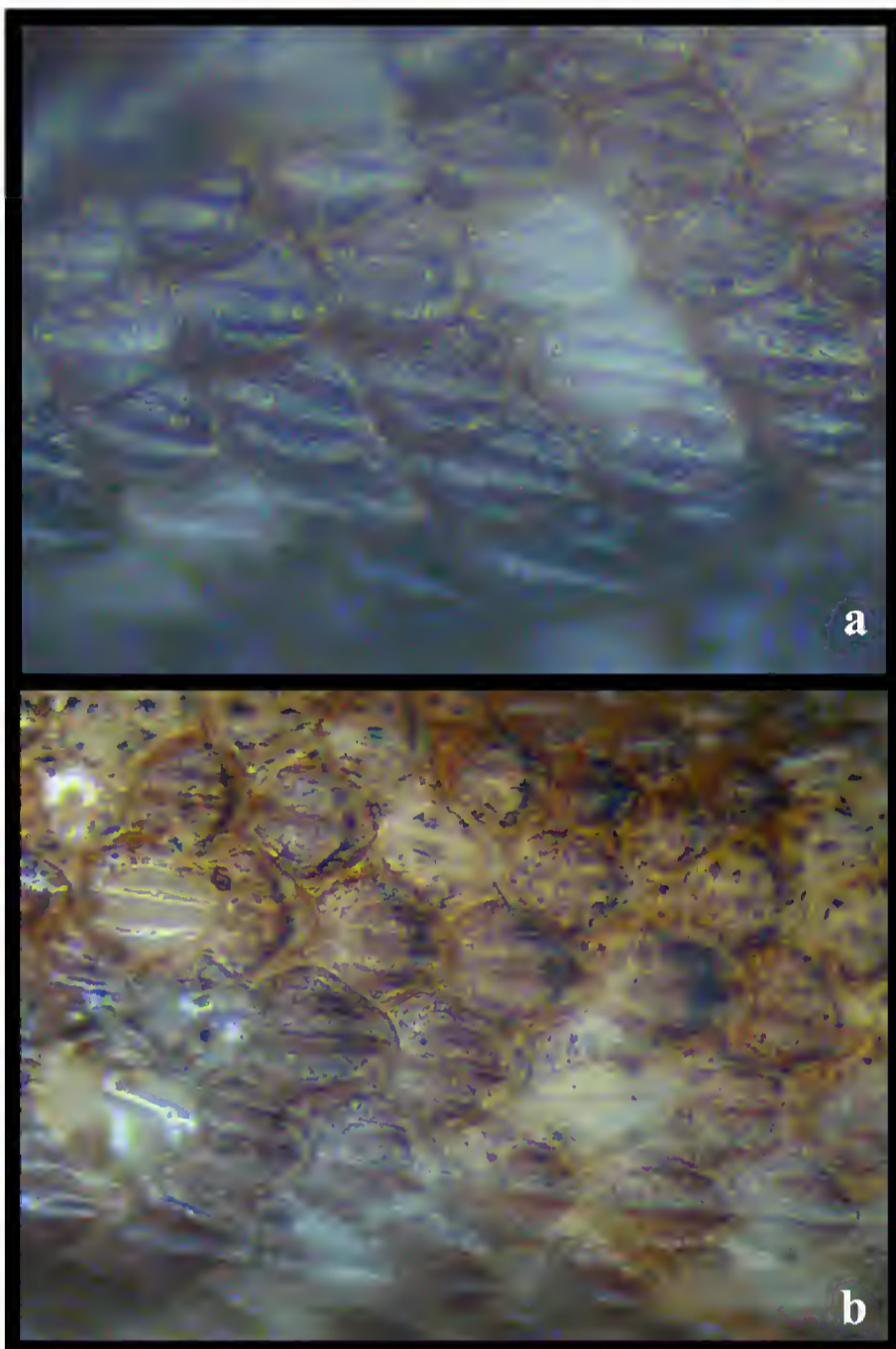
**Fig. 14.** (a) Dorsal and (b) ventral view of the full body of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458).



**Fig. 15 (above).** (a) Dorsal, (b) ventral, and (c) lateral view of the mid body of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458).



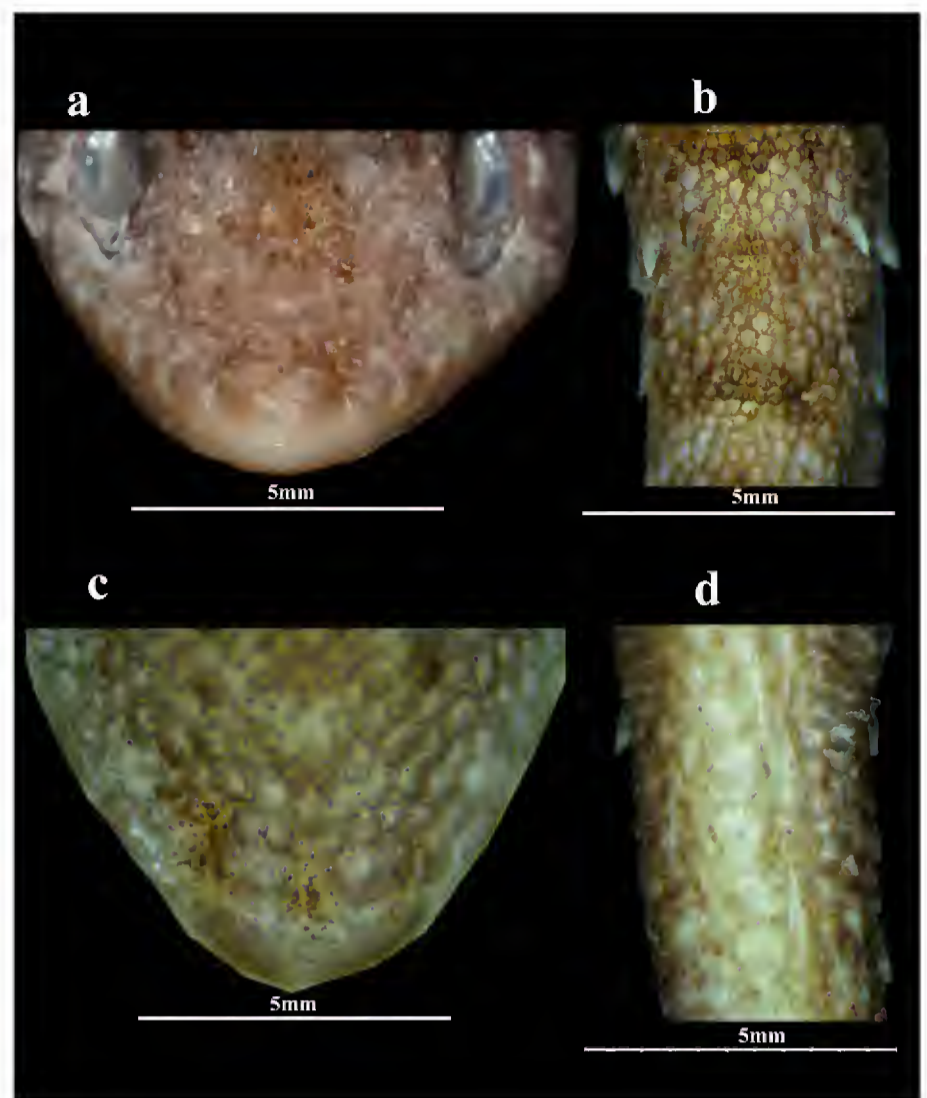
**Fig. 16 (right).** (a) Dorsal, (b) ventral, and (c) lateral view of the head, (d) ventral view of right manus, (e) ventral view of right pes, and (f) the lower body of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458).



**Fig. 17.** Showing tricarinate scales on (a) forelimb, (b) hindlimb of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458).

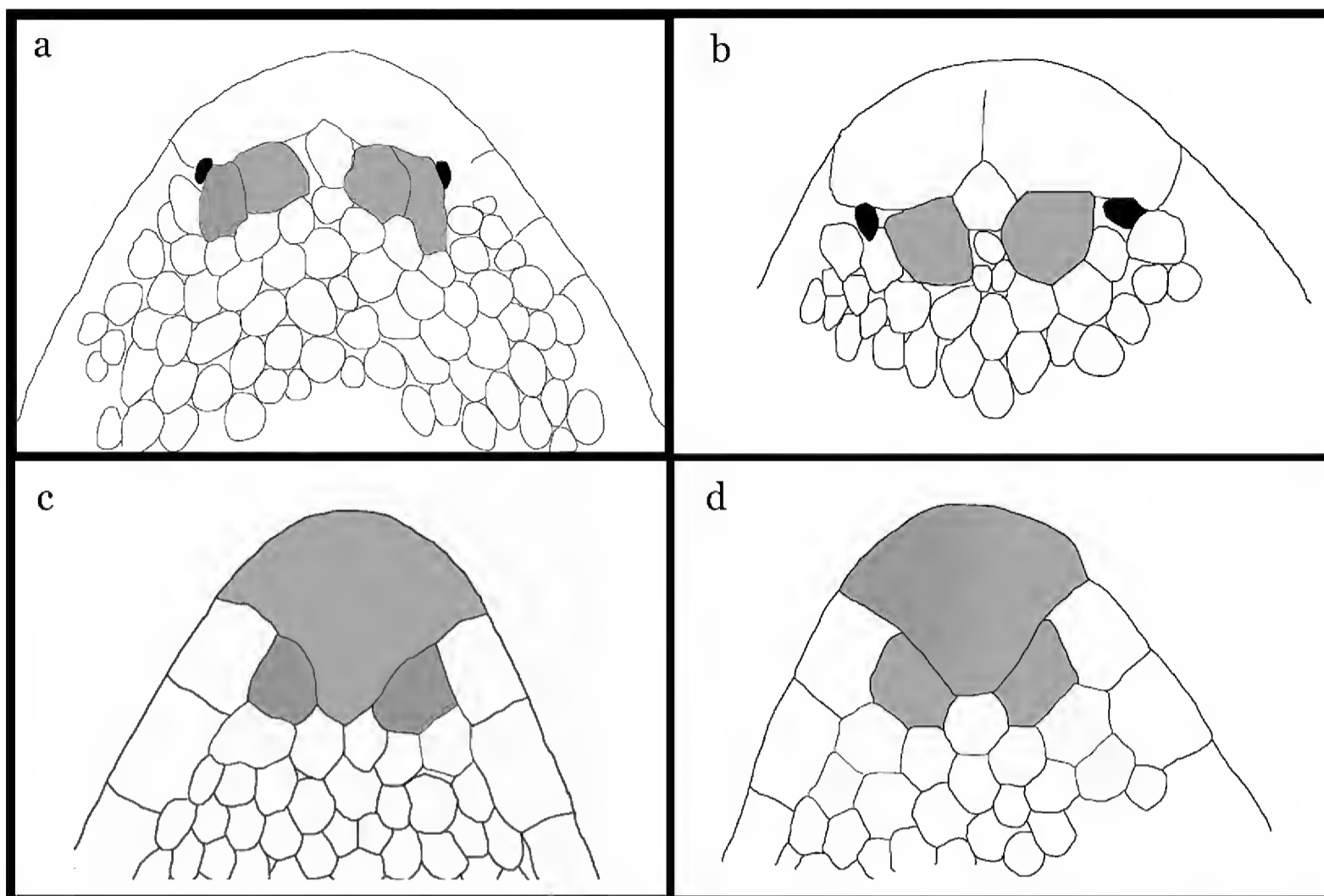
dal smooth, imbricate, second and third rows each side carinated, median row slightly enlarged; 6–7 lamellae on digit I of manus and 10 on digit IV, 6–7 on digit I of pes and 10–11 on digit IV; males with three or four pre-anal pores and 3–4 femoral pores on each side of thigh.

**Description of holotype:** BNHS 2458 (adult male); in good condition with an original tail (Fig. 14a, b); 29.87 mm SVL; head fairly short (HL/SVL = 0.19), wide (HW/HL = 0.90), slightly depressed (HD/HL = 0.55), distinct from moderately elongated neck; loreal not inflated, canthus rostralis not prominent; snout elongated (E-S/HL = 0.79), much longer than eye diameter (OD/E-S = 0.24); scales on snout, canthus rostralis and forehead granular, feebly keeled; scales on interorbital and occipital smaller, granular with some feebly keeled (Fig. 16a); eye moderately small (OD/HL = 0.19), pupil round; supraciliary scales slightly enlarged; ear opening small, oval shape, higher than wide (EL/HL = 0.03); eye to ear distance greater than diameter of eyes (E-E/OD = 1.77); rostral smooth wider than deeper, not swollen, medial groove absent (Fig. 16a, and Fig. 18a, c), in contact with first supralabial; nostrils not in contact with supralabial I; nares separated by two enlarged supranasals, three internasal scales, medial one moderately small, extends

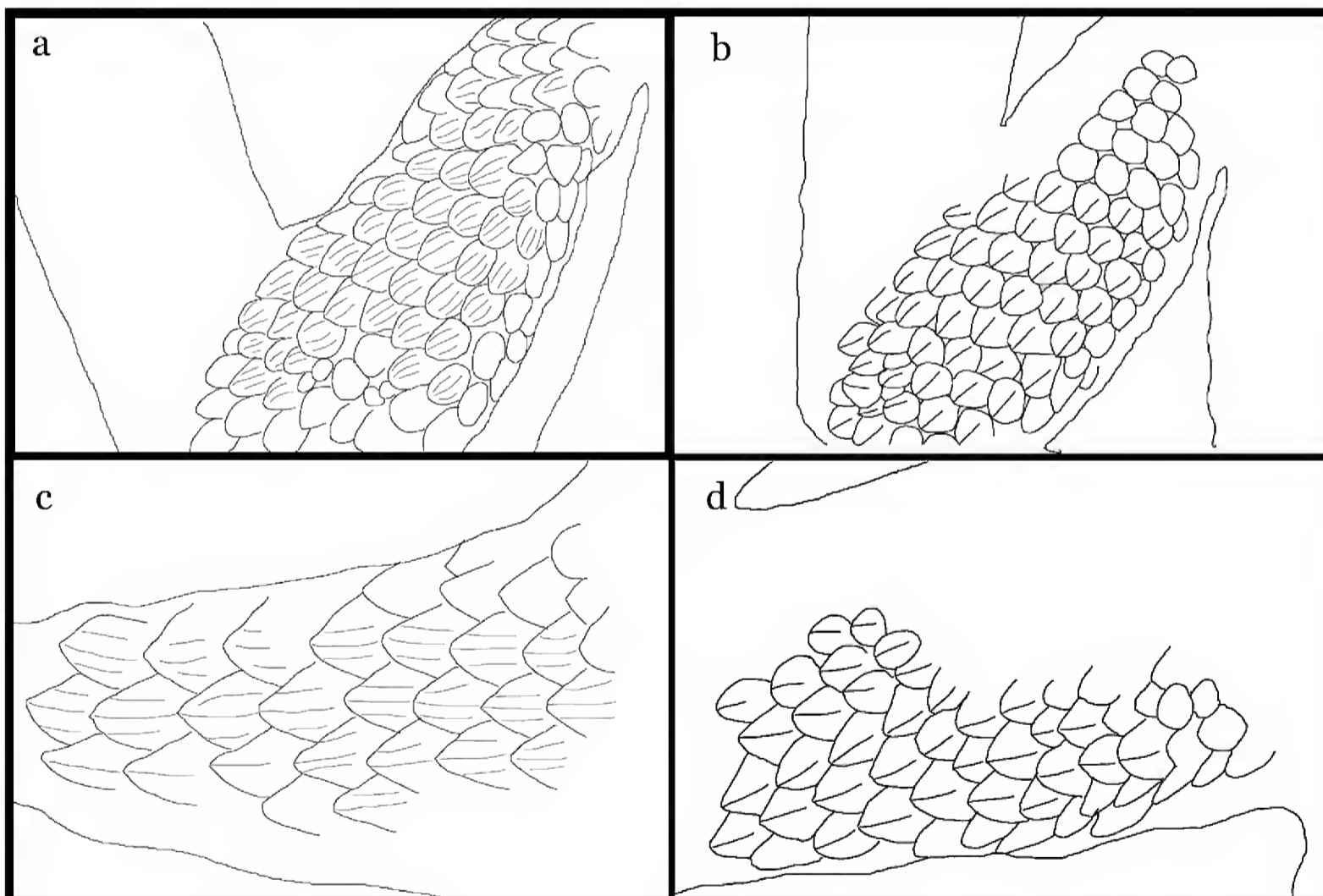


**Fig. 18.** Showing (a) rostral, (b) dorsal view of tail, (c) arrangement of nasals scales, (d) ventral view of tail of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458).

towards snout tip (Fig. 18a, c, and Fig. 19a); two rows of scales separate the orbit from the supralabials; mental sub-triangular, slightly wider (1.48 mm) than longer (1.31 mm), posteriorly not pointed; two pairs of postmentals, primary postmentals separated by mental, larger than secondary, surrounded laterally by first infralabial, secondary in contact with first and second infralabial (Fig. 16b and Fig. 19c); body relatively slender, not elongate (TRL/SVL = 0.38), without ventrolateral folds; supralabials to angle of jaw- seven right, eight left, at midorbital position- seven right, seven left; infralabials- seven left, seven right (Fig. 16c); dorsal scales on trunk heterogeneous, granular keeled small scales intermixed with some large keeled scales (Fig. 15a); neck and sacrum with feebly keeled scales, lateral part of the neck with granular, small feebly carinate scales; few conical tubercles and spine-like tubercles present on flank (Fig. 15c); ventral scales smooth, imbricate, larger than dorsal (Fig. 15b); 22 midbody scales across the belly between the lowest rows of dorsal scales; gular region with some feebly carinate scales, anterior gular scales smooth; three pre-anal and four femoral pores on each side (Fig. 16f); fore and hindlimbs relatively short, slender; forearm and tibia short (FL/SVL = 0.13; TBL/SVL = 0.14); dorsal scales of the forelimb and hindlimb tricarinate, keels well aligned to form more or continuous lines on dorsal part of humerus and femur, laterally carinate (Fig. 17a, b, and Fig. 20a, c), ventrally smooth; lamellae 7–8–11–10–9 right manus (Fig. 16d), 7–9–11–11–10 right pes (Fig. 16e); IV (3.05) > III (2.47) > II (2.35) > V (2.26) > I (1.47) (right manus); IV (4.06) > V (3.18) > III (3.16)



**Fig. 19.** Comparison of the snout and ventral regions. (a) Snout, (c) ventral view of head of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458), and (b) snout, (d) ventral view of head of *Cnemaspis goaensis* Holotype (male) (ZSI-K 22110).

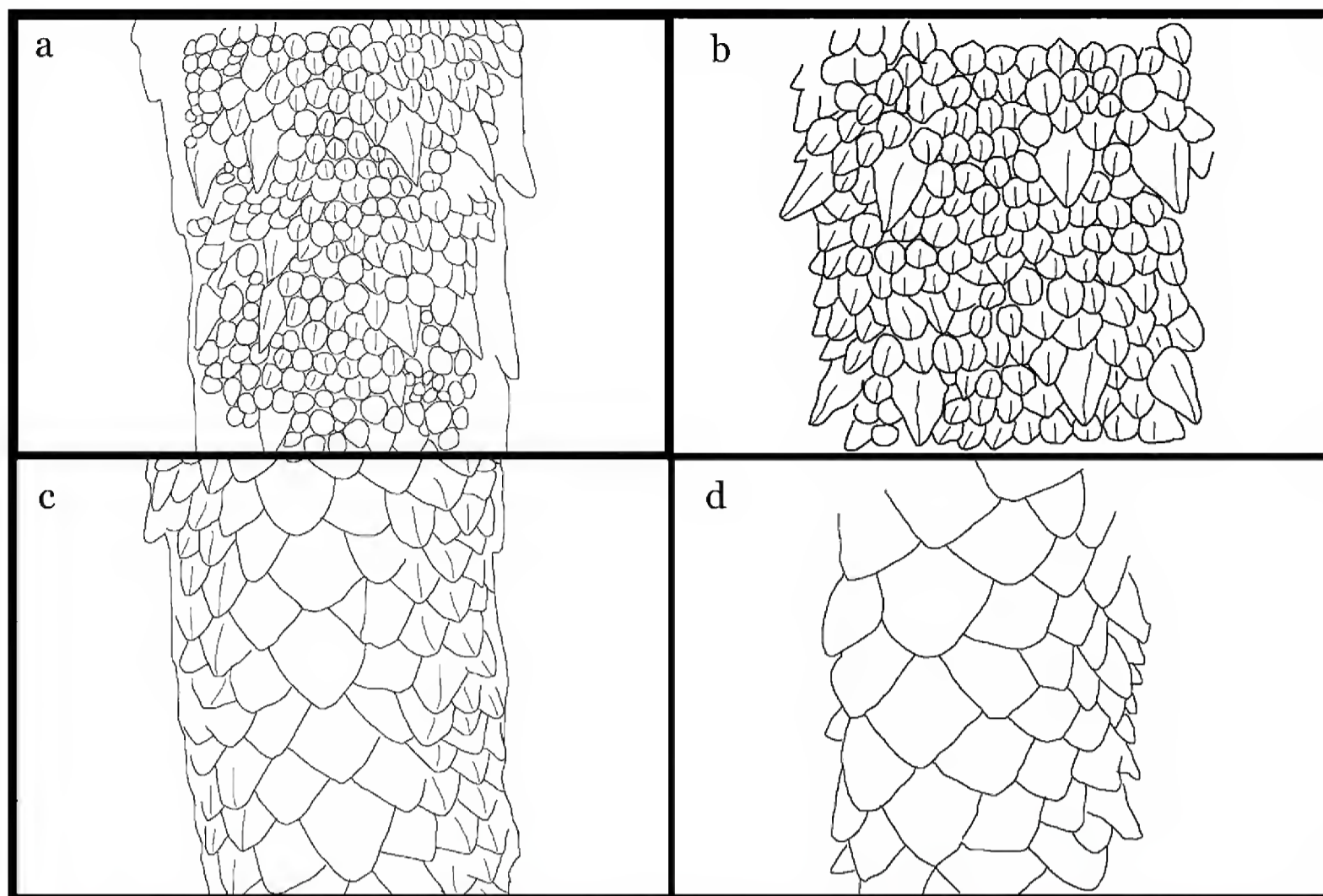


**Fig. 20.** Comparison of the dorsal scales of forelimb and hindlimb region. (a) Dorsal part of humerus, (c) dorsal part of femur region of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458), and (b) dorsal part of humerus, (d) dorsal part of femur region of *Cnemaspis goaensis* Holotype (male) (ZSI-K 22110).

> II (2.20) > I (1.33) (right pes), interdigital webbing absent; tail longer than snout-vent length (TaL/SVL = 1.21), sub-cylindrical, ventrally swollen; small triangular post-anal tubercles present along each side; sub-caudal smooth, imbricate, median row slightly enlarged, second and third rows each side carinated (Fig. 18d, 21c);

prominent acuminate keeled tubercles present with small keeled scales on dorsal tail (Fig. 18b, 21a).

**Color in life (Fig. 13):** Dorsal body brownish-yellow including tail; faded brown line present at interorbital region; lateral side of head and neck consists of two pale



**Fig. 21.** Comparison of the dorsal and ventral pholidosis of caudal region. (a) Dorsal, (c) ventral caudal region of *Cnemaspis amboliensis* sp. nov. Holotype (BNHS 2458), and (b) dorsal, (d) ventral caudal region of *Cnemaspis goaensis* Holotype (male) (ZSI-K 22110).

brown lines, one from nasal to mid eye, other posterior age of eye to ear; semicircle in brown marking on posterior head; dark-blackish-brown notched mark with a light-yellow patch in posterior end of it present on neck; supraciliaries yellow; labials light yellow with some dark-yellow spots; pupil rounded, black with surrounding yellow iris; ventral arm, throat, and ventral head light brown; venter dusty white; ventral hindlimb and ground of tail dusty white with irregular yellow markings; mid-dorsal area of body brownish-yellow, with five arrow-head shaped markings between fore and hindlimbs; some brown spots present in upper flank, slightly augmented by yellow on lower flank; original part of tail brownish-yellow, with pale brown bands.

**Color pattern in alcohol preservation (Fig. 14a, b):** Dorsum ground color became brownish, brown and black markings faded light; ventral body including tail color turned in to grey.

**Etymology:** The specific epithet *amboliensis* refers to the type locality Amboli, from which the type series was collected.

**Common name:** Amboli Day Gecko.

**Natural history:** This species was nocturnally active on the tree trunks and rocks of the wooded area of Amboli town (Fig. 22a) and was also found on the inside and outside of the walls of local houses and on the stone compound walls in Amboli town (Fig. 22b). They were not found active during the day time in the study area. Appar-

ently healthy populations of this species can be seen during June–September; we have observed gravid females in the months of September and October. The types were found sympatric with *Hemidactylus* sp., *Cyrtodactylus albofasciatus*, *H. prashadi*, *Cnemaspis kolhapurensis*, *C. flaviventralis*, *Bungarus caeruleus*, *Trimeresurus malabaricus*, *Lycodon travancoricus*, *Macropisthodon plumbicolor*, *Uropeltis* sp., *Raorchestes ghatei*, *Pseudophilautus amboli*, *Indirana chiravasi*, *Rhacophorus malabaricus*, *Xanthophryne tigerina*, and *Duttaphrynus melanostictus*.

**Distribution:** This species is currently known only from its type locality at Amboli (15.960N, 73.999E; 735 m asl), Sindhudurg district, Maharashtra, India. See Fig. 2 for the type locality of the species.

**Variation:** Adult specimens range in size from 28–32 mm (Table 3). All paratypes resemble the holotype except as follows: the number of lamellae on digit I of the manus is seven in all males, female BNHS 2459 with six, and 10 on digit IV in all the specimens, on digit I of the pes it is seven, specimen number BNHS 2507 male with six at left pes, female BNHS 2459 with six on left and right pes, and 10–11 on digit IV. Holotype male BNHS 2458 has four pre-anal and four femoral pores on each side. All specimens are almost similar with each other in color and in external features. Mensural data for the type series is given in Table 3.

**Remarks:** *Cnemaspis amboliensis* is distinguished from *C. goaensis* by having a maximum SVL 32 mm (vs. less





**Fig. 22.** (a) Forest, (b) Amboli town, habitat of *Cnemaspis amboliensis* sp. nov.

than 28.3 mm); rostral scale not divided, medial groove absent (vs. rostral scale partially divided by a medial groove); nares separated by two supranasals, of the three internasal scales, middle one extends towards snout tip (vs. nares separated by two enlarged supranasals, a single internasal); primary postmental scale separated by mental scale (vs. primary postmental scale separated by single gular scale); scales on ventral surface of neck smooth (vs. scales on ventral surface of neck feebly carinate); dorsal scales on forelimb and hindlimb tricarinate (vs. dorsal scales on both fore and hindlimb weakly carinate) (Table 6).

**Comparison:** *Cnemaspis amboliensis* may be distinguished from all other peninsular Indian congeners on the basis of the following differing or non-overlapping characters: dorsal scales on trunk heterogeneous (vs. dorsal scales homogenous in *C. adii*, *C. boiei*, *C. indica*, *C. indraneildasii*, *C. jerdonii*, *C. kolhapurensis*, *C. littoralis*, *C. mysoriensis*, *C. nilagirica*, *C. sisparensis*, and *C. wynadensis*); males with pre-anal and femoral pores (vs. males with femoral pores in *C. flaviventralis*, *C. girii*, *C. heteropholis*, and *C. kottiyooorensis*; no pre-anal or femoral pores in *C. assamensis*; two pre-anal pores present which is separated by two unpored scales, 3–5 femoral pores on each side in *C. gracilis*; femoral pores absent whereas pre-anal pores present in *C. nairi*); spine-like tubercles present on flanks (vs. spine like tubercles absent on flanks in *C. anaikattiensis*, *C. australis*,

*C. beddomei*, *C. ornate*, *C. otai*, and *C. yercaudensis*); sub-caudal slightly enlarged and smooth; rostral medial groove absent (vs. no median series of enlarged sub-caudals; rostral medial groove present in *C. flaviventralis*; sub-caudals enlarged, keeled intermixed with smooth, carinate scales; rostral scale partially divided by a medial groove in *C. monticola*; no median series of enlarged sub-caudals in *C. andersonii*); males with three or four pre-anal pores and 3–4 femoral pores on each side of the thigh; dorsal scales on forelimb and hindlimbs tricarinate, (vs. four pre-anal pores, four or five femoral pores on each side; dorsal scales on both fore and hind limbs smooth in *C. wicksi*); ventral scales smooth, imbricate; 19–22 midventrals (vs. ventral scales of the body keeled and imbricate; 28 midventrals in *C. tropidogaster*); from *Cnemaspis limayei* sp. nov. and *Cnemaspis ajiiae* sp. nov. by having conical and spine-like tubercles on flank; presence of pre-anal pores; 19–22 midventrals (vs. conical and spine-like tubercles absent; pre-anal pores absent in both species; 26–27 midventrals in *Cnemaspis limayei* sp. nov., 29–30 in *Cnemaspis ajiiae* sp. nov.). New species is similar in size and general appearance to *Cnemaspis goaensis*, however differs from this by rostral scale not divided, medial groove absent (Fig. 18a and 19a) (vs. rostral scale partially divided by a medial groove (Fig. 19b)); nares separated by two supranasals, of the three internasal scales, middle one extends towards snout tip (vs. nares separated by two enlarged supranasals, single internasal); primary postmental scale separated by mental scale (vs. primary postmental scale separated by single gular scale); scales on ventral surface of neck smooth (vs. scales on ventral surface of neck feebly carinate); granular keeled small scales intermixed with some large keeled scales dorsally; neck and sacrum with feebly keeled scales (vs. mid-dorsal granules, mixed with large keeled tubercles from head to sacrum); dorsal scales on forelimb and hindlimb tricarinate (Fig. 17a, b, and 20 a, c) (vs. dorsal scales on both fore and hindlimb weakly carinate (Fig. 20b, d)); lamellae manus 7–8–11–10–9, pes 7–9–11–11–10, measurement of right fingers: fourth finger larger than third, third larger than second, second larger than fifth, and fifth larger than first; toes: fourth larger than fifth, fifth larger than third, third larger than second, and second larger than first (vs. lamellae manus 9–12–13–15–11, pes 9–12–16–16–16; measurement of right fingers: fourth finger equal to second, third smaller than fourth and second, fifth smaller than third, and first smaller than fifth; toes: second larger than first, first larger than third, third larger than fourth, and fourth larger than fifth); sub-caudal smooth, imbricate, median row slightly enlarged, second and third rows each side carinated (Fig. 18d and 21c) (vs. median row of subcaudals slightly enlarged, smooth (Fig. 21d)); prominent acuminate keeled tubercles present with small keeled scales on dorsal tail (Fig. 18b and 21a) (vs. dorsal scales on mid-tail acute, imbricate, carinate (Fig. 21b)).

**Table 3.** Mensural and meristic data for the type series of *Cnemaspis amboliensis* sp. nov. Abbreviations as stated in Materials and Methods (\* = regenerated tail, ? = broken finger, - = pores not present).

Measurement (mm)	Holotype		Paratypes				
	BNHS 2458	BNHS 2504	BNHS 2505	BNHS 2459	BNHS 2506	BNHS 2507	BNHS 2508
	male	male	male	female	male*	male	male
(SVL)	29.87	28.60	29.24	31.47	28.61	28.74	29.85
(TRL)	11.52	12.24	11.91	14.52	12.37	12.17	12.54
(TrW)	6.30	5.98	6.19	7.19	5.45	6.31	6.45
(TaL)	36.27	37.30	33.69	34.78	28.88	29.98	30.45
(TaW)	2.97	2.84	2.99	2.54	3.36	2.96	3.01
(HL)	5.83	4.89	5.03	5.65	4.82	5.00	5.52
(HW)	5.26	5.10	5.13	4.88	5.15	4.64	5.04
(HD)	3.24	3.31	3.19	3.02	3.15	3.31	3.33
(FL)	4.03	3.97	4.26	4.47	4.12	4.23	4.39
(TBL)	4.39	4.32	4.37	4.74	4.80	4.64	4.63
(E-N)	3.79	3.24	3.45	3.94	3.35	3.39	3.79
(E-S)	4.66	4.17	4.29	4.63	3.98	4.40	4.64
(E-E)	2.01	2.63	2.92	2.39	2.29	2.30	2.88
(EL)	0.19	0.18	0.18	0.17	0.14	0.15	0.18
(IN)	0.90	1.02	0.99	0.99	1.00	0.99	1.01
(OD)	1.13	1.12	1.11	1.23	1.02	1.09	1.13
(IO)	2.67	2.86	3.02	2.72	2.92	2.63	2.84
HL/SVL	0.20	0.17	1.17	0.18	0.17	0.17	0.18
HW/SVL	0.18	0.18	0.18	0.16	0.18	0.16	0.17
HW/HL	0.90	1.04	1.02	0.86	1.07	0.93	0.91
E-S/HL	0.80	0.85	1.84	0.82	0.83	0.88	0.84
HD/HL	0.56	0.68	0.63	0.53	0.65	0.66	0.60
E-S/HW	0.89	0.82	0.84	0.95	0.77	0.95	0.52
OD/E-S	0.24	0.27	0.26	0.27	0.26	0.25	0.24
OD/HL	0.19	0.23	0.22	0.22	0.21	0.22	0.20
EL/HL	0.03	0.04	0.04	0.03	0.03	0.03	0.03
E-E/OD	1.78	2.35	2.63	1.94	2.25	2.11	2.55
TRL/SVL	0.39	0.43	0.07	0.46	0.43	0.42	0.42
FL/SVL	0.13	0.14	0.15	0.14	0.14	0.15	0.15
TBL/SVL	0.15	0.43	0.15	0.15	0.17	0.16	0.16
TaL/SVL	1.21	1.30	1.15	1.11	1.01	1.04	1.02
MVS	22	22	22	22	21	19	20
SupraL	7/8	7/8	8/8	7/8	8/8	8/7	7/8
InfraL	7/7	7/7	7/7	7/8	8/7	7/6	7/8
FPores	4 on each side	3 on each side	3 on each side	-	4 on each side	3 on each side	3 on each side
PaPores	4	3	3	-	3	4	4
MLam R	7-8-11-10-9	7-8-10-10-8	7-8-11-10-8	6-8-10-10-8	7-8-10-10-9	7-9-11-10-8	7-8-10-10-9
PLam R	7-9-11-11-10	7-8-11-10-10	7-9-10-10-10	6-8-10-10-10	7-8-10-11-11	7-9-11-10-10	7-8-11-11-10
MLam L	7-9-10-10-9	7-8-10-10-8	7-8-10-10-8	6-8-10-10-8	7-8-11-10-8	7-8-10-10-9	7-8-11-10-9
PLam L	7-9-10-11-10	7-8-11-10-?	7-8-10-10-10	6-8-11-10-10	7-9-11-11-10	6-7-10-11-11	7-8-11-10-10

***Cnemaspis mahabali* sp. nov. (Figs. 23–26)**

urn:lsid:zoobank.org:act:D25C0B90-783A-4057-9D68-278200660A0E

**Holotype:** BNHS 2449 (adult male) collected on 21 December 2016 at Bhira, near Tamhini (18.454N, 73.222E; 558 m asl), Pune district, Maharashtra, India.

**Paratypes:** BNHS 2502 and BNHS 2450 (adult male), BNHS 2451 and BNHS 2503 (adult female), have same collection data as holotype on the tree trunk.

**Diagnosis:** A medium-sized, robust *Cnemaspis* with maximum snout-vent length of 32.25 mm; dorsal scales heterogeneous consisting of granular small scales intermixed with few large feebly keeled scales; conical and spine-like tubercles absent on the flank; scales on neck not keeled; ventral part of neck feebly carinate; gular smooth; ventral scales of body smooth, imbricate, larger than dorsal; 26 midbody scales across the belly; dorsal scales of forelimb and hindlimb strongly keeled; ventral scales of both limbs smooth; scales on snout, canthus rostralis, and forehead granular, feebly keeled and those on interorbital and occipital smaller, granular; rostrum with partially dividing median groove, rostral in contact with first supralabial; nares separated from each other by two supranasals and a small internasal scale; nostrils not in contact with supralabial I; nasals bordered posteriorly by three post nasals; mental scale sub-triangular, longer than wider, posteriorly not pointed; two pairs of postmentals, primary postmentals separated by large median scales, primary postmentals larger than secondary, secondary postmentals in contact with first and second infralabial; supralabials 8–9; infralabials 7–8; three femoral pores on each side; 10–11 lamellae on digit IV of manus and 11–12 on digit IV of pes; extremely small post-anal spur along each side; sub-caudal smooth, imbricate, median row weakly enlarged; small keeled pointed tubercles present with small, keeled scales on dorsal tail.

**Description of holotype:** BNHS 2449 (adult male), in good condition with an entire tail (Fig. 24a, b). 31.06 mm SVL; head short (HL/SVL = 0.27), slightly wide (HW/HL = 0.60), depressed (HD/HL = 0.34); snout short (E-S/HL = 0.43), longer than eye diameter (OD/E-S = 0.27); scales on snout, canthus rostralis, forehead granular, feebly keeled; interorbital, occipital smaller, granular scales (Fig. 26a); eye small (OD/HL = 0.11), pupil round; supraciliary scales slightly enlarged; ear opening very small, higher than wide (EL/HL = 0.004); eye to ear distance greater than diameter of eyes (E-E/OD = 2.64); rostrum broader than long, with a partially dividing median groove, rostral in contact with first supralabial; nares separated from each other by two supranasals and a small internasal scale (Fig. 26a); nostrils not in contact with supralabial I; nasals bordered posteriorly by three post nasals (Fig. 26c); mental scale sub-triangular, longer than wide, posteriorly not pointed; two pairs of

postmentals, primary postmentals separated by large intermediate scales, primary postmentals larger than secondary, surrounded laterally by first infralabial, secondary in contact with first and second infralabial (Fig. 26b); body relatively slender, not elongate (TRL/SVL = 0.42), without ventrolateral folds; supralabials to angle of jaw-eight right, eight left; infralabials- seven left, eight right (Fig. 26c); dorsal scales on trunk heterogeneous, granular small scales intermixed with few large feebly keeled scales (Fig. 25a); scales on neck not keeled; scales on ventral part of neck feebly carinate; conical and spine-like tubercles absent on the flank (Fig. 25c); ventral scales smooth, imbricate, larger than dorsal (Fig. 25b); 26 midbody scales across belly between lowest rows of dorsal scales; gular smooth; three femoral pores on each side (Fig. 26f); fore and hindlimbs relatively short, slender; forearm and tibia short (FL/SVL = 0.12; TBL/SVL = 0.13); dorsal scales on forelimb and hindlimb strongly keeled; ventral scales of both limbs smooth; lamellae 7–9–11–10–9 right manus (Fig. 26d), 7–9–11–11–11 right pes (Fig. 26e); IV (2.58) > III (2.22) > II (2.04) > V (1.97) > I (1.72) (right manus); IV (3.30) > V (2.66) > III (2.65) > II (2.36) > I (1.61) (right pes), interdigital webbing absent; tail longer than snout-vent length (TaL/SVL = 1.15), sub-cylindrical, ventrally swollen; extremely small post-anal spur along each side; sub-caudal smooth, imbricate, median row weakly enlarged (Fig. 24b); small keeled pointed tubercles present with small, keeled scales on dorsal tail (Fig. 24a).

**Color in life (Fig. 23):** Dorsal part of body brown; dark-brown line present on canthal region connected with eye to nasal; chevron-like single mark on interorbital area; ‘W’ mark on head; small black patch on the nuchal; five dark-brown markings posteriorly surrounded by light-yellow present on mid dorsal body; supraciliaries brown; pupil circular, black with surrounding being reddish-brown; supralabial brown with orange spots; ventral side of body including throat grey; brown with light-yellow stripes on both limbs and on fingers; ventral side of lower and upper arm grayish; light-yellowish spots scattered in upper flank; original part of tail grayish-brown with few irregular dark-brown patches; ventral surface of tail grayish.

**Color pattern in alcohol preservation (Fig. 24a, b):** Dorsum body color became light brown; vertebral markings became dark-brown; dorsal part of limbs and tail became light brown with dark patches; one light brown radiating line from posterior edge of eyes; venter of throat, body and tail unpatterned yellowish-brown.

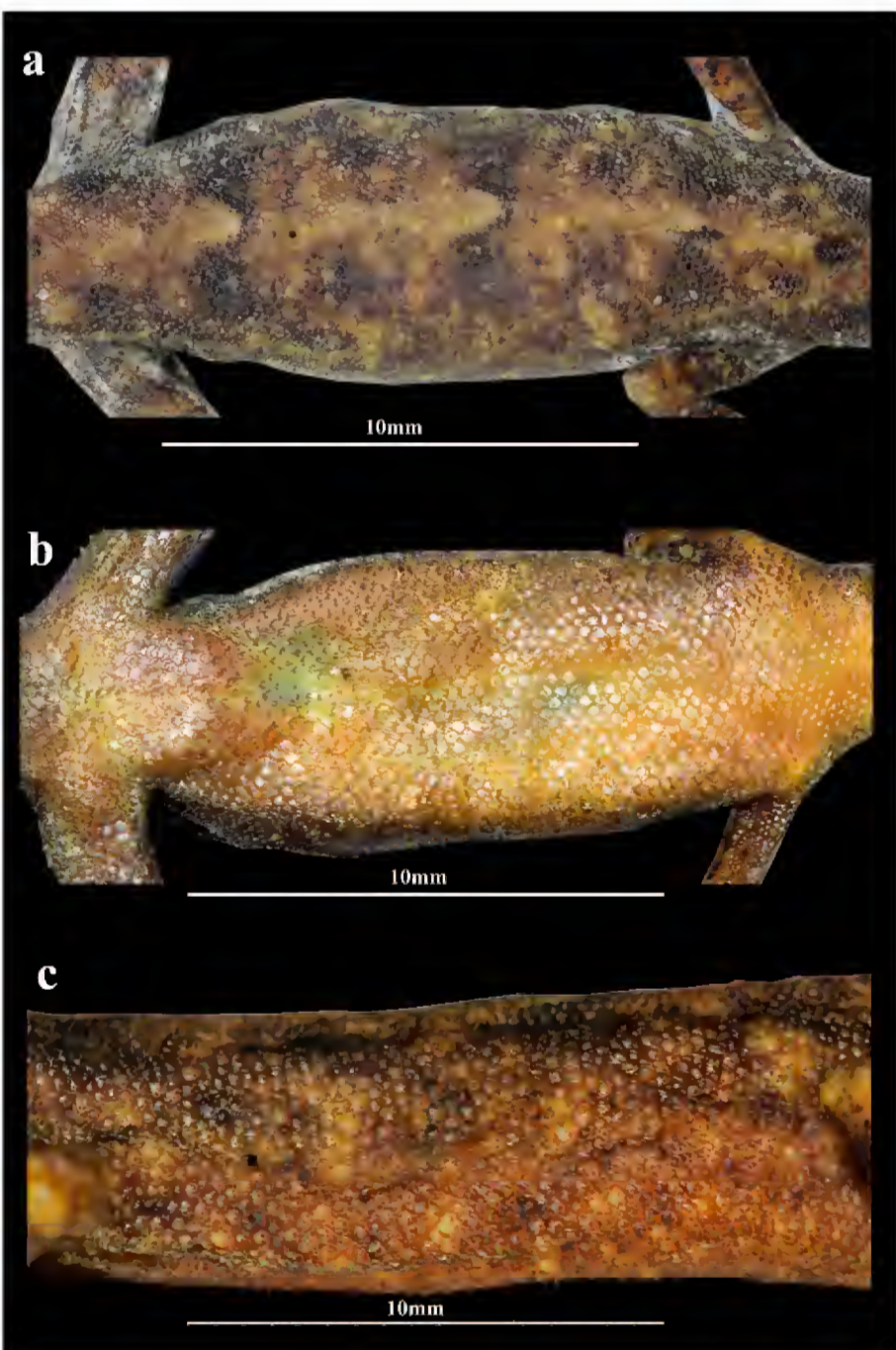
**Etymology:** The specific epithet is a patronym, honoring Mr. Anil Mahabal, retired scientist of Zoological Survey of India, Pune, Maharashtra, for his immense contribution to Indian natural history.



**Fig. 23.** Holotype male (BNHS 2449) of *Cnemaspis mahabali* sp. nov. in life.



**Fig. 24.** (a) Dorsal and (b) ventral view of the full body of *Cnemaspis mahabali* sp. nov. Holotype (BNHS 2449).



**Fig. 25.** (a) Dorsal, (b) ventral, and (c) lateral view of the mid body of *Cnemaspis mahabali* sp. nov. Holotype (BNHS 2449).

**Fig. 26 (right).** (a) Dorsal, (b) ventral, and (c) lateral view of the head, (d) ventral view of right manus, (e) ventral view of right pes, and (f) the lower body of *Cnemaspis mahabali* sp. nov. Holotype (BNHS 2449).

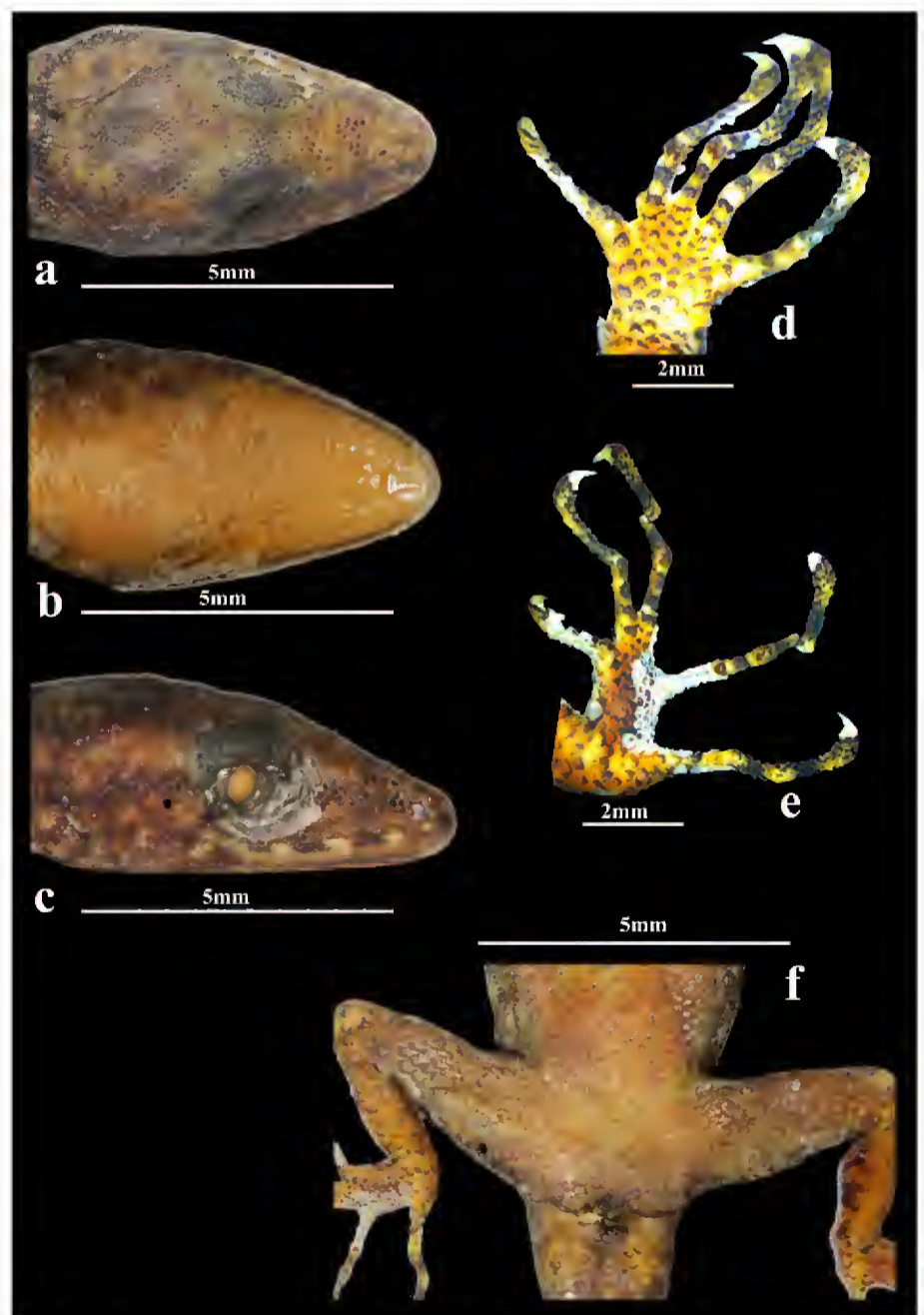




Fig. 27. Habitat of *Cnemaspis mahabali* sp. nov.

**Common name:** Mahabal's Day Gecko

**Natural history:** All specimens in the type series were collected at night on tree trunks and on branches. This species was not observed to be active in the day time during the study period. This species is widely distributed in the western parts of Maharashtra, recorded from the coastal area to up on the hills of the Western Ghats below the elevation 600 m from the sea level. Type locality of this gecko is Bhira, near Tamhini, Pune district, Maharashtra, India (Fig. 27a, b), where all the specimens were collected. The types were found sympatrically with *Hemidactylus* sp., *H. cf. maculates*, *Macropisthodon plumbicolor*, *Duttaphrynus melanostictus*, *Raorchestes ghatei*, and *Polypedates maculates*.

**Distribution:** This species is widely distributed in most parts of the coastal forest and hilly regions of western Maharashtra. In this study we have reported this species from Ratnagiri district, parts of Thane district, the hilly area of Raigad district, and Pune district. Live specimens were examined from Devrukh, Guhagar, Chiplun, Mulshi, Tail Baila, Patnus, Bhira, Phansad, Mangaon, Tambadi, and Uran in Maharashtra. Type specimens were collected from Bhira, near Tamhini (18.454N, 73.222E; 558 m asl), Pune district, Maharashtra, India. See Fig. 2 for the type locality of the species.

**Variation:** Adult specimens range in size from 27–33 mm (Table 4). All paratypes resemble the holotype and

all specimens are similar with each other in color and in external features.

**Remarks:** *Cnemaspis mahabali* is distinguished from *C. girii*, *C. flaviventralis*, and *C. ajijae* by several morphological characters. *C. mahabali* can easily be distinguished from *C. girii* and *C. flaviventralis* by lacking conical tubercles on the flanks; low count of midventrals 19–22; scales on ventral part of neck carinate; and from *C. ajijae* by having few large weakly keeled scales on the dorsal body; carinate scales on ventral part of neck; two pairs of postmentals (Table 6).

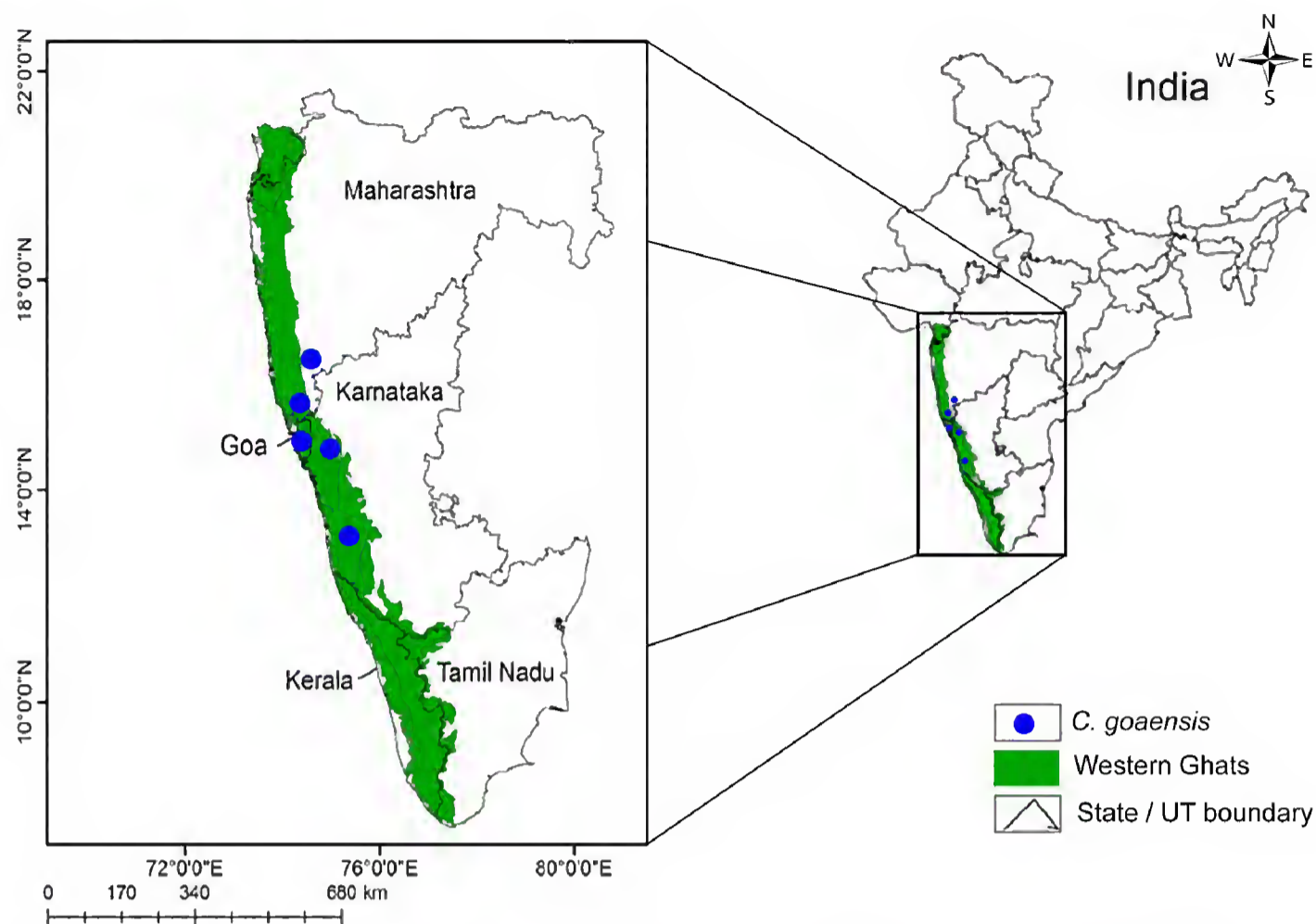
**Comparison:** *Cnemaspis mahabali* may be distinguished from all other peninsular Indian congeners on the basis of the following differing or non-overlapping characters: dorsal scales on trunk heterogeneous (vs. dorsal scales homogenous in *C. adii*, *C. boiei*, *C. indraneildasii*, *C. indica*, *C. jerdonii*, *C. kolhapurensis*, *C. littoralis*, *C. mysoriensis*, *C. nilagirica*, *C. sisparensis*, and *C. wynadensis*); conical and spine-like tubercles absent on the flank (vs. spine-like tubercles present on flank in *C. assamensis*, *C. indraneildasii*, *C. jerdonii*, *C. littoralis*, *C. monticola*, *C. mysoriensis*, *C. nilagirica*, and *C. tropidogaster*, conical tubercles present on flanks in *C. kottiyooorensis* and *C. flaviventralis*); males with three femoral pores on each side (vs. males with six femoral pores in *C. heteropholis*, five in *C. indica*, 5–15 in *C. jerdonii*, 15–18 in *C. littoralis*, 7–8 in *C. sisparensis*, 4–6 in *C. wynadensis*; males with pre-anal as well as femoral pores in *C. andersonii*, *C. australis*, *C. goaensis*, *C. gracilis*, *C. mysoriensis*, *C. otai*, and *C. yercaudensis*; femoral pores absent whereas pre-anal pores present in *C. beddomei*, *C. nairi*, and *C. ornata*; pores absent in both sexes of *C. assamensis* and *C. boiei*; continuous series of 24–28 pre-anal femoral pores in *C. kolhapurensis*); two pairs of postmentals (vs. three pairs of postmentals in *C. ajijae* sp. nov. and *C. anaikattiensis*); gulars scales smooth; scales on ventral part of neck feebly carinate (vs. gulars scales carinate in *C. andersonii*, scales on ventral part of neck smooth in *C. kolhapurensis* and *C. flaviventralis*); differs from *Cnemaspis amboliensis* sp. nov. by conical and spine-like tubercles absent on flank; 26 midventrals; dorsal scales on forelimb and hindlimbs strongly keeled; three femoral pores (vs. conical and spine-like tubercles on flank; 19–22 midventrals; dorsal scales on forelimb and hindlimb tricarinate; males with three or four pre-anal pores and 3–4 femoral pores).

This new species is similar in size and general appearance to *Cnemaspis girii*, *C. ajijae*, and *C. limayei*, but differs from these by having large feebly keeled scales on dorsal part of body; conical tubercles absent on flank; 26 midventrals; scales on ventral part of neck feebly carinate; two pairs of postmentals; dorsal scales on forelimb and hindlimb strongly keeled; inner surface of forelimb and hindlimb smooth; three femoral pores on each side; pre-anal scales same as ventral scales of the body; small

**Table 4.** Mensural and meristic data for the type series of *Cnemaspis mahabali* sp. nov. Abbreviations as stated in Materials and Methods (# = juvenile, ? = broken finger, - = pores not present).

Measurement (mm)	Holotype		Paratypes		
	BNHS 2449	BNHS 2450	BNHS 2502	BNHS 2451	BNHS 2503
	male	male	male	female	female #
(SVL)	31.06	30.72	27.93	32.25	18.11
(TRL)	13.10	13.14	11.22	14.08	7.04
(TrW)	6.83	6.15	6.33	8.49	2.95
(TaL)	35.76	32.95	31.87	34.33	19.02
(TaW)	2.80	2.73	2.51	3.02	0.87
(HL)	8.63	7.70	7.71	8.02	5.51
(HW)	5.24	5.33	4.88	5.68	3.02
(HD)	2.97	3.32	3.16	3.49	1.86
(FL)	3.95	4.92	3.92	4.92	2.03
(TBL)	4.31	5.47	4.17	5.61	2.94
(E–N)	2.93	2.97	2.99	3.16	1.68
(E–S)	3.74	3.80	3.67	4.07	2.35
(E–E)	2.72	2.80	2.48	2.84	1.48
(EL)	0.04	0.05	0.04	0.05	0.02
(IN)	0.82	0.92	0.82	0.97	0.59
(OD)	1.03	1.09	1.03	1.20	0.87
(IO)	3.61	3.48	3.09	3.34	2.04
HL/SVL	0.27	0.25	0.27	0.24	0.30
HW/SVL	0.16	0.17	0.17	0.17	0.16
HW/HL	0.60	0.69	0.63	0.70	0.54
E–S/HL	0.43	0.49	0.48	0.50	0.42
HD/HL	0.34	0.43	0.40	0.43	0.33
E–S/HW	0.71	0.71	0.75	0.71	0.77
OD/E–S	0.27	0.28	0.28	0.29	0.37
OD/HL	0.11	0.14	0.13	0.14	0.15
EL/HL	0.004	0.006	0.005	0.006	0.003
E–E/OD	2.64	2.56	2.40	2.36	1.70
TRL/SVL	0.42	0.42	0.40	0.43	0.38
FL/SVL	0.12	0.16	0.14	0.15	0.11
TBL/SVL	0.13	0.18	0.14	0.17	0.16
TaL/SVL	1.15	1.07	1.14	1.06	1.05
MVS	26	26	26	26	26
SupraL	8/8	9/9	9/9	9/9	8/8
InfraL	8/7	7/7	8/8	8/7	7/7
FPores	3 on each side	3 on each side	3 on each side	-	-
MLam R	7-9-11-10-9	8-9-10-10-9	8-8-11-11-9	8-9-10-10-9	7-8-11-10-9
PLam R	7-9-11-11-11	7-9-11-11-11	8-9-11-11-11	7-9-11-11-10	7-9-11-11-11
MLam L	8-8-10-11-9	8-9-10-10-9	8-8-10-11-9	8-9-11-11-9	?-8-10-10-8
PLam L	7-9-11-11-11	7-9-11-11-11	8-9-11-11-10	7-9-11-12-10	?

## Four new species of the genus *Cnemaspis*



**Fig. 28.** Map showing distribution of *Cnemaspis goaensis*, in the parts of south Maharashtra, Goa and Karnataka, India. Localities indicated by blue circles.

keeled pointed tubercles present on dorsal tail (vs. large smooth scales on dorsal aspect; conical tubercles present; part of neck smooth; inner surface of forelimb and hindlimb keeled; large pointed tubercles present on the dorsal tail in *C. girii*; dorsal granular, keeled scales intermixed with large keeled depressed scales; part of neck smooth; 29–30 midventrals; three pairs of postmentals in *C. aijiae* sp. nov.; dorsal scales feebly keeled; intermixed with large keeled depressed scales; part of neck smooth; pre-anal scales large than ventral; males with 4–5 femoral pores on each side in *C. limayei* (Table 6).

### Discussion

In their important work on South Asian *Cnemaspis*, Manamendra-Arachchi et al. (2007) reported 34 species from peninsular India and Sri Lanka, based on their exploration and discovery of many species in Sri Lanka. They also predicted that the number of species was likely to increase substantially, especially with further explorations in the Western Ghats. However, in the last few years only five species, *C. kolhapurensis*, *C. girii*, *C. kottiyooensis*, *C. adii*, and *C. flaviventralis*, have been described from the Western Ghats, and only a single species from Sri Lanka, *C. kandambyi* (Uetz and Hošek 2017). This is likely due to the slow pace at which systematic surveys are being carried out, and the intensive investment of time and money needed for accurate taxonomic work in such a small-bodied and cryptic taxon. The discovery of four new species in the current study is therefore not surprising.

Our taxonomic sampling for genetic analysis is still incomplete. Nevertheless, we show that all the proposed

species are morphologically distinct from their Indian congeners and genetically distinct from geographically proximate species. Two of our species, *C. mahabali* and *C. limayei*, are closely related and form a clade with *C. girii*. However, the three species can be separated based on the presence or absence of canonical tubercles on flanks, number of midventral scales, and the number of lamellae under digit IV of the pes. Genetically, these species are separated by at least 2.8% uncorrected genetic distance from each other.

Intraspecific genetic distances of 1.5% were observed among the specimens of *C. aijiae* collected from Panchgani and parts of Mahabaleshwar Satara, Maharashtra. This suggests potential cryptic diversity within *C. aijiae*. Nevertheless, the specimens from these localities were morphologically similar. Additionally, Srinivasulu et al. (2014) provide a point locality for *C. indraneildasii* described by Bauer (2002) from Mahabaleshwar, attributing the record to Smith (1935). They, however, do not provide rationale for this record. Although *C. aijiae* from Mahabaleshwar can be confused with *C. indraneildasii*, they can easily be distinguished from one another by the following morphological characters: spine-like tubercles absent on flank (vs. present) and dorsal scales on trunk heterogeneous (vs. homogenous).

With description of four new species of *Cnemaspis*, the total number of species within this genus from India is elevated to 33. The description of several new species from the Western Ghats suggests that our understanding of species richness within this genus is still limited, and that undescribed diversity likely still remains. Several species of this genus are assessed as either Near Threatened or Data Deficient by the IUCN (Srinivasulu et al.





## Four new species of the genus *Cnemaspis*

**Table 6.** Comparative account according to the original description of the genus *Cnemaspis* from the northern Western Ghats and geographically close species from southern Western Ghats (? = data not available, - = pores not present), Abbreviations: see Materials and Methods.

Species and locality	Sptub	PaPores	FPores	MVS	SupraL	SVL	Lamp IVth
<i>Cnemaspis limayei</i> sp. nov. (Sindhudurg, Maharashtra)	absent	-	5	26–27	7–9	31 mm	10–12
<i>Cnemaspis aijjae</i> sp. nov. (Satara, Maharashtra)	absent	-	3–4	29–30	7–8	37 mm	11–13
<i>Cnemaspis amboliensis</i> sp. nov. (Sindhudurg, Maharashtra)	present	3–4	3–4	19–22	7–8	32 mm	10–11
<i>Cnemaspis mahabali</i> sp. nov. (Pune, Maharashtra)	absent	-	3	26	8–9	32.25 mm	11–12
<i>Cnemaspis kolhapurensis</i> (Kolhapur, Maharashtra)	absent	24–28	-	20–23	6	40 mm	10–12
<i>Cnemaspis girii</i> (Satara, Maharashtra)	absent	-	4	26–28	7–8	35 mm	17–20
<i>Cnemaspis goaensis</i> (Goa)	present	3	2–4	18–22	8	28.03 mm	16
<i>Cnemaspis adii</i> (Ballari, Karnataka)	absent	2	2	22–26	8–9	35 mm	20–22
<i>Cnemaspis heteropholis</i> (Uttara Kannada, Karnataka)	absent	-	6	20–22	9–8	45.01 mm	?
<i>Cnemaspis flaviventralis</i> (Sindhudurg, Maharashtra)	absent	-	3	28–29	7–9	36.04 mm	10–12

2014). Thus, additional taxonomic and natural history investigations are needed to determine the true richness, species limits, and conservation status of South Asian *Cnemaspis*. While one of our new species, *C. amboliensis*, appears to be common and widespread and is thus likely not of great conservation concern, the other three

are known from very small geographic areas and did not appear to have abundant populations. Thus, they may be imperiled by IUCN criteria.

Based on the morphological divergence described here for the northern Western Ghats species, a comparative account for those and the geographically proximate

### Key to the species of *Cnemaspis* in northern Western Ghats

#### 1) *Cnemaspis goaensis*

Dorsal scales on body heterogeneous; gulars weakly carinate; pre-anal and femoral pores present in males; subcaudals slightly enlarged and smooth (Sharma RC 1976; Manamendra-Arachchi et al. 2007).

#### 2) *Cnemaspis kolhapurensis*

Dorsal scales homogenous, small and feebly keeled; no spine-like tubercles on flanks; a continuous series of 24–28 precloacal-femoral pores (Giri et al. 2009).

#### 3) *Cnemaspis girii*

Dorsal scales heterogeneous; large scales on the dorsal part of body smooth; keeled conical tubercles on flank; males with four femoral pores (Mirza et al. 2014).

#### 4) *Cnemaspis flaviventralis*

Dorsal scales heterogeneous; large keeled conical tubercles on flanks; three pairs of postmentals; without a series of enlarged median subcaudal scales; males with three femoral pores (Sayyed et al. 2016).

#### 5) *Cnemaspis limayei* sp. nov.

Dorsal scales on body heterogeneous; conical and spine-like tubercles absent on flank, almost homogeneous; pre-anal scales large than ventral; males with four- five femoral pores; sub-caudals not enlarged.

#### 6) *Cnemaspis aijjae* sp. nov.

Dorsal scales on body heterogeneous; granular keeled scales intermixed with large keeled depressed scales; conical and spine-like tubercles absent on flank; three pairs of postmentals; males with three or four femoral pores.

#### 7) *Cnemaspis amboliensis* sp. nov.

Dorsal scales on body heterogeneous; granular, conical and spine-like tubercles on flank; scales on snout feebly keeled; dorsal scales of the forelimb and hindlimb tricarinate; three or four pre-anal pores and three to four femoral pores on each side of the thigh.

#### 8) *Cnemaspis mahabali* sp. nov.

Dorsal scales on body heterogeneous; conical and spine-like tubercles absent on the flank; scales on ventral part of neck feebly carinate; dorsal scales of the forelimb and hindlimb strongly keeled; three femoral pores on each side.

**Table 7.** GenBank accession numbers for the DNA-sequence dataset.

No	Species	Locality	Voucher	16S
1	<i>Cnemaspis mahabali</i> sp. nov	Pune, Maharashtra	BNHS 2451	MH174353
2	<i>Cnemaspis mahabali</i> sp. nov	Pune, Maharashtra	BNHS 2502	MH174352
3	<i>Cnemaspis mahabali</i> sp. nov	Pune, Maharashtra	BNHS 2503	MH174354
4	<i>Cnemaspis amboliensis</i> sp. nov	Sindhudurg, Maharashtra	BNHS 2458	MH174358
5	<i>Cnemaspis amboliensis</i> sp. nov	Sindhudurg, Maharashtra	BNHS 2505	MH174355
6	<i>Cnemaspis amboliensis</i> sp. nov	Sindhudurg, Maharashtra	BNHS 2507	MH174357
7	<i>Cnemaspis amboliensis</i> sp. nov	Sindhudurg, Maharashtra	BNHS 2508	MH174356
8	<i>Cnemaspis aijjae</i> sp. nov	Satara, Maharashtra	ZSI WRC R/1055	KX753650
9	<i>Cnemaspis aijjae</i> sp. nov	Satara, Maharashtra	ZSI WRC R/1056	KX753651
10	<i>Cnemaspis aijjae</i> sp. nov	Satara, Maharashtra	ZSI WRC R/1057	KX753652
11	<i>Cnemaspis aijjae</i> sp. nov	Satara, Maharashtra	ZSI WRC R/1058	KX753653
12	<i>Cnemaspis aijjae</i> sp. nov	Satara, Maharashtra	ZSI WRC R/1059	KX753648
13	<i>Cnemaspis aijjae</i> sp. nov	Satara, Maharashtra	ZSI WRC R/1060	KX753649
14	<i>Cnemaspis limayei</i> sp. nov	Sindhudurg, Maharashtra	ZSI WRC R/1052	KX753646
15	<i>Cnemaspis limayei</i> sp. nov	Sindhudurg, Maharashtra	ZSI WRC R/1053	KX753647
16	<i>Cnemaspis yercaudensis</i>	Salem, Tamil Nadu	BNHS 2509	MH174359
17	<i>Cnemaspis yercaudensis</i>	Salem, Tamil Nadu	BNHS 2510	MH174360
18	<i>Cnemaspis otai</i>	Vellore, Tamil Nadu	BNHS 2511	MH174361
19	<i>Cnemaspis otai</i>	Vellore, Tamil Nadu	BNHS 2512	MH174362
20	<i>Cnemaspis gracilis</i>	Palakkad, Kerala	BNHS 2513	MH174369
21	<i>Cnemaspis gracilis</i>	Palakkad, Kerala	BNHS 2514	MH174370
22	<i>Cnemaspis indica</i>	Nilgiris, Tamil Nadu.	BNHS 2515	MH174365
23	<i>Cnemaspis indica</i>	Nilgiris, Tamil Nadu.	BNHS 2516	MH174366
24	<i>Cnemaspis littoralis</i>	Kozhikode, Kerala	BNHS 2517	MH174367
25	<i>Cnemaspis littoralis</i>	Kozhikode, Kerala	BNHS 2518	MH174368
26	<i>Cnemaspis kottiyorensis</i>	Kannur, Kerala	BNHS 2519	MH174363
27	<i>Cnemaspis wynadensis</i>	Wayanad, Kerala	BNHS 2520	MH174364
28	<i>Cnemaspis indraneildasii</i>	Uttara Kannada, Karnataka	BNHS 2460	KX753656
29	<i>Cnemaspis indraneildasii</i>	Uttara Kannada, Karnataka	BNHS 2461	KX753657
30	<i>Cnemaspis indraneildasii</i>	Uttara Kannada, Karnataka	BNHS 2462	KX753658
31	<i>Cnemaspis indraneildasii</i>	Uttara Kannada, Karnataka	BNHS 2463	KX753659
32	<i>Cnemaspis goaensis</i>	Kolhapur, Maharashtra	CnKh 33	MH174375
33	<i>Cnemaspis goaensis</i>	Kolhapur, Maharashtra	ChKh 34	MH174376
34	<i>Cnemaspis goaensis</i>	Kolhapur, Maharashtra	CnKo 48	MH174377
35	<i>Cnemaspis goaensis</i>	Kolhapur, Maharashtra	CnKo 49	MH174378
36	<i>Cnemaspis goaensis</i>	Shimoga, Karnataka	CnInAr 1	MH174371
37	<i>Cnemaspis goaensis</i>	Shimoga, Karnataka	CnInAr 2	MH174372
38	<i>Cnemaspis goaensis</i>	Shimoga, Karnataka	CnInA 1	MH174373
39	<i>Cnemaspis goaensis</i>	Shimoga, Karnataka	CnInA 2	MH174374
40	<i>Cnemaspis flaviventralis</i>	Sindhudurg, Maharashtra	ZSI WRC R/1042	KX269819
41	<i>Cnemaspis flaviventralis</i>	Sindhudurg, Maharashtra	ZSI WRC R/1043	KX269820
42	<i>Cnemaspis girii</i>	Satara, Maharashtra	BNHS 2445	KX269823
43	<i>Cnemaspis girii</i>	Satara, Maharashtra	BNHS 2446	KX269824
44	<i>Cnemaspis kolhapurensis</i>	Sindhudurg, Maharashtra	BNHS 2447	KX269821
45	<i>Cnemaspis kolhapurensis</i>	Sindhudurg, Maharashtra	BNHS 2448	KX269822
46	<i>Cnemaspis heteropholis</i>	Shimoga, Karnataka	BNHS 2466	KX753660
47	<i>Cnemaspis adii</i>	Ballari, Karnataka	BNHS 2464	KX753654
48	<i>Cnemaspis adii</i>	Ballari, Karnataka	BNHS 2465	KX753655
49	<i>Cnemaspis goaensis</i>	Goa	ZSI WRC R/1044	KX269825
50	<i>Cnemaspis goaensis</i>	Goa	ZSI WRC R/1045	KX269826

species from the southern Western Ghats is provided (Table 6). Furthermore, we provide a key to the northern Western Ghats species as follows:

## Appendix

***Cnemaspis goaensis*:** Holotype (male) ZSI-K 22110, ZSI-K 22213–22216 (four paratypes); “ca. 3 km S. of Forest Rest House, Canacona (Poinguinim), Goa.” Also, two specimens of *Cnemaspis goaensis*, ZSI R/1044 and ZSI R/1045, were collected outside the protected area near the type locality of the species, for examination and used for genetic analysis.

***Cnemaspis goaensis*:** CnKh 33, ChKh 34, CnKo 48, and CnKo 49 collected from the human habitation at Kolhapur, district Maharashtra, for examination and used for genetic analysis.

***Cnemaspis indraneildasii*:** BNHS 2460 and BNHS 2461 collected from Gund and specimens BNHS 2462 and BNHS 2463 from Dandeli, Karnataka. CnInAr 1 and CnInAr 2 collected from Agumbe road, specimens CnInA 1 and CnInA 2 collected near Agumbe, Shimoga district, Karnataka. Collected for examination and used for genetic analysis.

***Cnemaspis adii*:** BNHS 2464 and BNHS 2465 collected from the Hampi, Karnataka type locality of the species, for examination and used for genetic analysis.

***Cnemaspis yercaudensis*:** BNHS 2509 and BNHS 2510 collected from the Yercaud town, Tamil Nadu, for examination and used for genetic analysis.

***Cnemaspis otai*:** BNHS 2511 and BNHS 2512 collected from the Vellore fort, Tamil Nadu, for examination and used for genetic analysis.

***Cnemaspis gracilis*:** Voucher specimen (male) BNHS 1182; Goa. Also, two specimens of *Cnemaspis gracilis*, BNHS 2513 and BNHS 2514, collected from the Palakkad, Kerala, for examination and used for genetic analysis.

***Cnemaspis indica*:** Voucher specimens BNHS 1252-10 (male) and BNHS 1252-1 (female); Nilgiris, Tamil Nadu. Also, two specimens of *Cnemaspis indica*, BNHS 2515 and BNHS 2516, collected from Ooty, Tamil Nadu, for examination and used for genetic analysis.

***Cnemaspis girii*:** Holotype (male) BNHS 2299; Kaas plateau, Satara district, Maharashtra; paratypes BNHS 2081 (male) and BNHS 2078 (female); other details same as holotype. Also, two specimens of *Cnemaspis girii*, BNHS 2445 and BNHS 2446, collected from the type locality of the species for examination and used for genetic analysis.

***Cnemaspis flaviventralis*:** Holotype (male) BNHS 2442, Paratypes (male) BNHS 2443, ZSI-WRC R/1039, ZSI-WRC R/1042, (female) BNHS 2444, ZSI-WRC R/1040, ZSI-WRC R/1041, ZSI-WRC R/1043, examined and

(male) ZSI-WRCR/1042, (female) ZSI-WRCR/1043 used for genetic analysis. All specimens were collected from Amboli Sindhudurg district, Maharashtra.

***Cnemaspis littoralis*:** Voucher specimen (male) BNHS 1150; Nilambur, Malabar. Also, two specimens of *Cnemaspis littoralis*, BNHS 2517 and BNHS 2518, collected from the Kozhikode, Kerala, for examination and used for genetic analysis.

***Cnemaspis kolhapurensis*:** Holotype (male) BNHS 1855; Dajipur, Kolhapur district, Maharashtra. Also, two specimens of *Cnemaspis kolhapurensis*, BNHS 2447 and BNHS 2448, collected from Amboli, Sindhudurg district, Maharashtra, for examination and used for genetic analysis.

***Cnemaspis heteropholis*:** BNHS 2466 collected from the Shimoga, Karnataka, for examination and used for genetic analysis.

***Cnemaspis kottiyooensis*:** BNHS 2519, collected from the Kannur, Kerala, for examination and used for genetic analysis.

***Cnemaspis wynadensis*:** Voucher specimen BNHS 1042 (male) and BNHS 1043 (male); Mannarghat, Palghat, Kerala. Also, one specimen of *Cnemaspis wynadensis*, BNHS 2520, collected from the Vythiri, Kerala, for examination and used for genetic analysis.

### The specimens used for new species described in this paper:

***Cnemaspis limayei* sp. nov.:** ZSI WRC R/1052 and ZSI WRC R/1053, collected from the Sindhudurg district, Maharashtra, used for genetic analysis.

***Cnemaspis ajijae* sp. nov.:** ZSI WRC R/1055, ZSI WRC R/1056, ZSI WRC R/1057, ZSI WRC R/1058, ZSI WRC R/1059, and ZSI WRC R/1060, collected from the Satara, Maharashtra, used for genetic analysis.

***Cnemaspis amboliensis* sp. nov.:** BNHS 2458, BNHS 2505, BNHS 2507, and BNHS 2508, collected from Sindhudurg, Maharashtra, used for genetic analysis.

***Cnemaspis mahabali* sp. nov.:** BNHS 2451, BNHS 2502, and BNHS 2503, collected from Pune, Maharashtra, used for genetic analysis.

The source of morphological comparison data for *C. adii* was taken from Srinivasulu et al. (2015); for *C. australis*, *C. monticola*, *C. nilagirica*, *C. beddomei*, *C. boiei*, *C. ornata*, *C. andersonii*, *C. jerdonii*, *C. wicksii*, *C. goaensis*, and *C. sisparensis* from Manamendra-Arachchi et al. (2007); for *C. indraneildasii* from Bauer (2002); for *C. heteropholis* from Bauer (2002) and Ganesh et al. (2011); for *C. otai* and *C. yercaudensis* from Das and Bauer (2000); for *C. anaikattiensis* from Mukherjee et al. (2005); for *C. mysoriensis* from Giri et al. (2009); for *C. kottiyooensis* from Cyriac and Umesh (2014); for *C. assamensis* from Das and Sengupta (2000); for *C. nairi* and

*C. tropidogaster* from Inger, Marx, and Koshy (1984); for *C. kolhapurensis* from Giri et al. (2009); and for *C. girii* from Mirza et al (2014).

**Acknowledgements.**—The authors are thankful to the following: Hemant Ghate and Robert Powell for their support and help in the work; Neelesh Dahanukar for the molecular work and his support in the work; Rajgopal Patil for his support in the work; Anilkumar Khaire for inspiration; Principal Chief Conservator of Forests (Wildlife) and Chief Wildlife Warden, Maharashtra State for granting the Permit to AS, (D-22(8)/WL/CR-94 (14-15)/638/2015-16); Forest Departments of Tamil Nadu, and Kerala for the Permit to RD (WL10-41691/2014 and 94/2009/ & WLD). We are thankful to Patrick Campbell, Natural History Museum, London; Deepak Apte, Director and Rahul Khot, museum curator, Bombay Natural History Society, Mumbai for granting access to specimens and registration of the type specimens, and Vithoba Hegde, senior field assistant, Priya Wareker, research fellow, and Sham Jadhav, assistant, for their help; the Officer In-charge and Shrikant Jadhav, scientist, Zoological Survey of India, Western Regional Center, Pune, for their help and the registration of the type specimens; Rajesh Sanap, Vivek Sharma, Zeeshan Mirza, Harshal Bhosle, and Amod Zhambre for the motivation. Field work would not have been possible without the help of Kaka Bhise in Amboli and Vinod Shrivardhankar in Bhirra. Thanks to Abhijit Nale, Kapil Taple, Rahul Thombre, Mangesh Karve, Aman Adsul, Kiran Ahire, Devendra Bhosle, Ashutosh Suryavanshi, Satyajit Gujar, Nitesh Anandan, Chaitanya Shukla, and Hrishikesh Awale, members of WLPRS. RAP was funded by US NSF grant DEB-1441719.

## Literature Cited

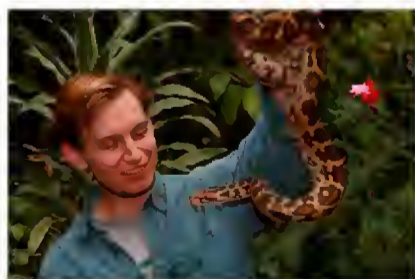
- Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. 1990. Basic local alignment search tool. *Journal of Molecular Biology* 215: 403–410. [http://dx.doi.org/10.1016/S0022-2836\(05\)80360-2](http://dx.doi.org/10.1016/S0022-2836(05)80360-2).
- Bauer AM. 2002. Two new species of *Cnemaspis* (Reptilia: Squamata: Gekkonidae) from Gund, Uttara Kananda, India. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 99: 155–167.
- Cyriac VP, Umesh PK. 2013. Current status of *Cnemaspis littoralis* (Jerdon, 1853) (Sauria: Gekkonidae) with designation of a neotype. *Taprobanica* 5: 36–43. <http://dx.doi.org/10.4038/tapro.v5i1.5660>.
- Cyriac VP, Umesh PK. 2014. Description of a new ground-dwelling *Cnemaspis* Strauch, 1887 (Squamata: Gekkonidae), from Kerala, allied to *C. wynadensis* (Beddome, 1870). *Russian Journal of Herpetology* 21: 187–194.
- Dahanukar N, Modak N, Krutha K, Nameer PO, Padhye AD, Molur S. 2016. Leaping frogs (Anura: Ranixalidae) of the Western Ghats of India: An integrated taxonomic review. *Journal of Threatened Taxa* 8(10): 9,221–9,288. <http://dx.doi.org/10.11609/jott.2532.8.10.9221-9288>.
- Das I, Bauer AM. 2000. Two new species of *Cnemaspis* (Sauria: Gekkonidae) from Tamil Nadu, southern India. *Russian Journal of Herpetology* 7: 17–28.
- Das I, Sengupta S. 2000. A new species of *Cnemaspis* (Sauria: Gekkonidae) from Assam, northeastern India. *Journal of South Asian Natural History* 5: 17–23.
- Edgar RC. 2004. MUSCLE: Multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research* 32: 1,792–1,797. <http://dx.doi.org/10.1093/nar/gkh340>.
- Gamble T, Greenbaum E, Jackman TR, Russell AP, Bauer AM. 2012. Repeated origin and loss of adhesive toepads in geckos. *PLOS ONE* 7(6): e39429. <http://dx.doi.org/10.1371/journal.pone.0039429>.
- Ganesh SR, Sreekar R, Pal SP, Ramchandra G, Srinivasulu C, Srinivasulu B. 2011. Discovery and first description of male *Cnemaspis heteropholis* Bauer, 2002 (Reptilia: Gekkonidae) from Agumbe, central Western Ghats, India. *Journal of Threatened Taxa* 3: 2,023–2,027. <http://dx.doi.org/10.11609/JoTT.o2614.2023-7>.
- George RP. 1973. *A Guide to Preservation Techniques for Amphibians and Reptiles*. Herpetological Circular No. 1, Society for the Study of Amphibians and Reptiles. 22 p. Available: [http://people.ku.edu/~gpisani/HC\\_1.pdf](http://people.ku.edu/~gpisani/HC_1.pdf).
- Giri VB, Agarwal I, Bauer AM. 2009a. Designation of a neotype for *Cnemaspis mysoriensis* (Jerdon 1853) (Sauria: Gekkonidae), with a redescription and notes on its distribution and habitat. *Russian Journal of Herpetology* 16: 256–264.
- Giri VB, Bauer AM, Gaikwad SK. 2009b. A new ground-dwelling species of *Cnemaspis* Strauch (Squamata: Gekkonidae) from the northern Western Ghats, Maharashtra, India. *Zootaxa* 2164: 49–60.
- Guindon S, Dufayard JF, Lefort V, Anisimova M, Hordijk W, Gascuel O. 2010. New algorithms and methods to estimate maximum-likelihood phylogenies: Assessing the performance of PhyML 3.0. *Systematic Biology* 59: 307–321. <http://dx.doi.org/10.1093/sysbio/syq010>.
- Inger RF, Marx H, Koshy M. 1984. An undescribed species of gekkonid lizard (*Cnemaspis*) from India with comments on the status of *C. tropidogaster*. *Herpetologica* 40: 149–154.
- Kumar S, Stecher G, Tamura K. 2016. MEGA7: Molecular Evolutionary Genetics Analysis version 7.0 for bigger datasets. *Molecular Biology and Evolution* 33: 1,870–1,874.
- Manamendra-Arachchi K, Batuwita S, Pethiyagoda R. 2007. A taxonomic revision of the Sri Lankan day-geckos (Reptilia: Gekkonidae: *Cnemaspis*), with description of new species from Sri Lanka and southern India. *Zeylanica* 7: 9–122.

## Four new species of the genus *Cnemaspis*

- Milne I, Lindner D, Bayer M, Husmeier D, McGuire G, Marshall DF, Wright F. 2008. TOPALi v2: A rich graphical interface for evolutionary analyses of multiple alignments on HPC clusters and multi-core desktops. *Bioinformatics* 25: 126–127. <http://dx.doi.org/10.1093/bioinformatics/btn575>.
- Mirza ZA, Pal S, Bhosale HS, Sanap RV. 2014. A new species of gecko of the genus *Cnemaspis* Strauch, 1887 from the Western Ghats, India. *Zootaxa* 3815: 494–506. <http://dx.doi.org/10.11646/zootaxa.3815.4.2>.
- Mukherjee D, Bhupathy S, Nixon AMA. 2005. A new species of day gecko (Squamata, Gekkonidae, *Cnemaspis*) from the Anaikatti Hills, Western Ghats, Tamil Nadu, India. *Current Science* 89: 1,326–1,328.
- Nei M, Kumar S. 2000. *Molecular Evolution and Phylogenetics*. Oxford University Press, New York, New York, USA. 333 p.
- Pyron RA, Burbrink FT, Wiens JJ. 2013. A phylogeny and updated classification of Squamata, including 4,161 species of lizards and snakes. *BMC Evolutionary Biology* 13: 93. <http://dx.doi.org/10.1186/1471-2148-13-93>.
- Rambaut A. 2009. FigTree, ver. 1.4.2. [Online]. Available: <http://tree.bio.ed.ac.uk/software/figtree/> [Accessed: 28 February 2015].
- Sayyed A, Pyron RA, Dahanukar N. 2016. *Cnemaspis flaviventralis*, a new species of gecko (Squamata: Gekkonidae) from the Western Ghats of Maharashtra, India. *Journal of Threatened Taxa* 8(14): 9,619–9,629. <http://dx.doi.org/10.11609/jott.2599.8.14.9619-9629>.
- Schwarz G. 1978. Estimating the dimension of a model. *Annals of Statistics* 6: 461–464.
- Smith MA. 1933. Remarks on some Old World geckoes. *Records of the Indian Museum* 35: 9–19.
- Smith MA. 1935. *The Fauna of British India, Including Ceylon and Burma; Reptilia and Amphibia*. Vol. II: Sauria. Taylor and Francis, London, England. xiv + 440 p., 2 folding maps, 1 plate.
- Srinivasulu C, Kumar GC, Srinivasulu B. 2015. A new species of *Cnemaspis* (Sauria: Gekkonidae) from Northern Karnataka, India. *Zootaxa* 3947: 85–98. <http://dx.doi.org/10.11646/zootaxa.3947.1.5>.
- Srinivasulu C, Srinivasulu B, Molur S, compilers. 2014. *The Status and Distribution of Reptiles in the Western Ghats, India*. Conservation Assessment and Management Plan (CAMP), Wildlife Information Laision Development Society, Coimbatore, Tamil Nadu, India. 148 p.
- Strauch AA. 1887. Bemerkungen über die Geckoniden-Sammlung im zoologischen Museum der kaiserlichen Akademie der Wissenschaften zu St. Petersburg. *Mémoires de l'Académie impériale des Sciences de St. Pétersbourg* 35: 1–72.
- Uetz P, Hošek J, editors. 2017. The Reptile Database. Available: <http://www.reptile-database.org> [Accessed: 22 May 2017].



**Amit Sayyed** is a head researcher at the Wildlife Protection and Research Society, India. He is working on the faunal diversity and conservation of reptiles; his main interests have been in the taxonomy of geckos and frogs. He has published several papers on natural history, faunal diversity, and descriptions of new species. Amit is the author of three books: *Amazing Creature of the Earth (Snakes of Maharashtra, Goa and Karnataka)*, *Butterflies and Spiders of The Western Ghats*, and *Dangerous Bite and First Aid*. His PhD focused on wildlife and wildlife conservation. He plans to pursue his further studies on phylogenetic systematics, taxonomy, and natural history of the Indian *Cnemaspis*.



**Alex Pyron** is an Associate Professor of Biology at George Washington University. He works on theoretical and applied methods in statistical phylogenetics, using reptiles and amphibians as model groups.



**Dr. Dileepkumar R** is currently Principal Investigator under Young Investigator's Programmer in Biotechnology in the Centre for Venom Informatics, University of Kerala. He is also co-investigating projects in the area of venomomics supported by KSCSTE, Govt. of Kerala. His research broadly encompasses the venomomics, venom gland transcriptomics, and genomics of venomous snakes. His ongoing projects are centered on understanding the venom composition of venomous species in the animal kingdom. His publications, book chapters, etc., focus on snake taxonomy, venomomics, and applications of medical technologies.